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**A Systematic Approach
for the Analysis, Design and Implementation of
Telecommunications-Supported Training (TST)
Systems**

Cristina Simón
(B.Sc., Universidad Autónoma de Madrid)

Thesis submitted for the degree of Doctor of Philosophy
Discipline: Technologies of Education (Faculty of Technology)

The Open University

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Abstract

The objective of the present thesis is to develop and test out a systematic approach to the analysis, design and implementation of Telecommunications-Supported Training (TST) systems. The Literature Review offers a set of approaches to similar problems in the field of Information Systems. Several other disciplines have also been considered: Psychology of Human Factors, Organizational and Innovation Theory, and applied research being currently carried out under the EU DELTA Programme.

A global User-Centred Model of TST has been developed, based on the well-established principles of Systems Engineering and Soft Systems Methodology. The theoretical basis for this model is the concept of TST Architecture, conceived as a functional arrangement of technical components which are introduced in order to improve the performance of the actors involved in the system. The other key aspect is the design of a set of Adoption Strategies, aiming for the creation of the necessary conditions to achieve user acceptance of the technologies implemented.

Following these principles, the ADAM (Architectural Design and Adoption Model) systematic approach is developed. It is structured in five stages: Context Analysis, System Analysis, System Design, System Implementation and System Maintenance. Each stage is structured into steps and activities, described in terms of key points, outcomes, deliverables, and roles involved.

The ADAM approach has been tested out in its twofold dimension of analyzing already implemented TST systems and designing new ones. The first case discusses the application of ADAM to the EU Multimedia TeleSchool (MTS) TST system. The test is completed by discussing the design and implementation, performed by the author, of a TST system at the Universidad Politécnica de Madrid.

The results confirm the usefulness of ADAM both for practitioners and researchers in the field. Also, the TST model is extended as regards the components of acceptance and adoption, and their impact on the introduction of technologies in organizations.

To Guillermo Alonso

Acknowledgements

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Several people have also supported my day-to-day work, putting up with my stress and encouraging me at every moment, as my peers at the Universidad Politécnica de Madrid Pablo Martín and Carmen Viorreta. Susan Webster, another OU student, has shared with me the not-so-good aspects of Distance Learning. My colleague and friend Jaime Moreno has also encouraged me throughout the process. My family have understood my absences, and have made me feel that the effort was worthwhile. Finally, this work would not have been possible without the support of my husband. Many thanks to all of them.

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Chapter 1

Rationale

1.1. Problem Addressed by the Work

1.2. The Need for a Systematic Approach to TST: Lessons from ISD

1.3. Requirements of a Systematic Approach to TST

1.4. Research Questions

1.5. Method of Work

1.6. Summary

1.1. Problem Addressed by the Work

Information and Telecommunications technologies (ITT) are becoming all-pervasive in every field of human and social activity. The area of training is obviously not escaping their application. Higher education centres and corporations increasingly recognize the need to incorporate these technologies into learning processes, if current and future generations are to adapt and become competitive in their respective environments: *"Human resource development and especially training and retraining through technologies will be a key asset and investment for European institutions wishing to get human resources ready to keep a leading competitive position."* (R. Huber, Director DGXIII-F of the European Union, in Van den Brande, 1993, p.233).

Within the framework of this political trend, the last few years have seen strategical and prospective studies in which experts have attempted to analyze the future roles and environments that the use of learning technologies will bring about (OTA, 1989; Martin et al., 1994; Cassidy and Lane, 1994). The application of ITT is also influencing the conceptions of teaching and learning used for a long

time (Merril et al., 1990; Hudspeth, 1992; Goodrum et al., 1993; Alexander and Mason, 1994). Moreover, its use is gaining strategic importance, deeply influencing the management structure of the organizations intending to adopt them. A good example of this development is the widespread educational reform currently underway in the US, based on the same technological support underlying the teaching and learning-related processes (Cassidy and Lane, 1994; Lane and Cassidy, 1994).

Research concerning the design and implementation of these technologies, however, has not yet been fully consolidated. A recent review of research performed in this field by the Association for Educational Communications and Technology (Thomson et al., 1992) states that "... the best uses of technology (...) are just beginning to be identified." (pp. 68). Some of the recommendations for research include aspects such as the examination of the institution restructuring in the light of technology, or how to use it in creating realistic and more effective learning environments (op.cit.). The comments of Reeves (1993) provide a vivid illustration, while referring to the development of experiences in the field of interactive multimedia, he states that "... much of the development and most of the implementation seem to be guided by habit, intuition, prejudice, guesswork or politics." (pp. 79).

Most of Reeves' statement is applicable to the Telecommunications-Supported Training (TST) field. Although a growing number of reports show that applications are being researched and implemented with many different aims and addressing a wide variety of users (Mason, 1989; Simonson and Jurasec, 1992; Boettcher, 1993; Van den Brande, 1993), design processes have so far been characterized by a diversity of perspectives (CTA Consortium, 1994). In fact, as we will see in the review of the literature, research publications (browsed through electronic databases such as ERIC and ICDL) contain no references proposing

systematic approaches, based on well-established methodological research areas, to the design of TST systems.

The situation limits progress in this field, both from the researcher's and the practitioner's points of view. In the author's opinion, this situation has been brought about by the factors which originally prompted this thesis and which are the following:

- From a research point of view, there is found to be an absence of integrated TST systems models, combining human, social and organizational factors with technological dimensions. Consequently:
 - results cannot often be generalized, due to the lack of uniform terminology,
 - the highly interdisciplinary character of TST experiences means that project perspectives may be partial, putting undue emphasis either on technological factors or on basic pedagogical research,
 - there is a lack of well-established comprehensive methods of definition and evaluation of TST-related variables, though methodologies in partial application areas are being produced (Hiltz, 1988; Mason, 1992; Phelan, 1993)
 - it should be taken into account that the results of training are in themselves difficult to measure and the causes of success or failure are multi-dimensional and therefore complex to state (Buckley and Caple, 1990).

In practical terms, the situation should be observed from a project management viewpoint. In this sense, the work of researchers in education as well as in other areas of technology-supported human activity (Willcocks, 1991; King and Cornell, 1992) reveals the following types of problems:

- The participation of different professionals usually causes communication problems, hindering the effective conversion of organizational and user needs into technological support.

- The absence of control mechanisms and follow-up. As the projects frequently involve isolated developments that have to be integrated in the final stages, the lack of these elements is particularly prejudicial.
- Users' reactions to technological implementations, usually either rejecting or simply ignoring them.

The lack of systematic methods of designing and implementing TST solutions has been stated both by researchers and practitioners within the framework of the EU DELTA R&D Programme:

"Projects expressed the need to elaborate a model which is a sort of intermediate between a general model scenario and a down-to-earth report listing all the steps undertaken: a sort of interplay between a generalization model and a narration of events. The model could give guidance, establish a process to analyze the problems of implementation and the tools to analyze them, defining a methodology to solve them."

(DeCoMe13, SIG "Implementation of Learning Technology", May 1994, sic.)

In view of this problem situation, the present thesis claims that the development of a global model of TST and a systematic approach to the analysis, design and implementation of Telecommunications-Supported Training would represent a significant advance in this field, both from the theoretical and the applied points of view.

In order to constitute a proper solution to the problems stated above, such an approach should contribute to research and practice in the following ways:

- As for research, the model should be able to provide consistent terminology, that researchers, trainers, developers, managers and users can all share. In being integrative, it should also adopt a holistic approach, thus taking into

account all the factors potentially influencing the process. The provision of such a model would undoubtedly set up a framework in which results from different experiences could be compared and merged into "collective thinking" (Flagg, 1990).

- From the practitioner's perspective, the advantages of a systematic approach become apparent in the control and accountability of the project. A staged conception of the process and a deliverable-based structure are invaluable tools as far the management of such complex, interdisciplinary problems is concerned. As in the case of research, the provision of a terminology would also be beneficial in facilitating communication among the actors. The approach should include a mechanism for designing the measures needed to introduce properly the technologies into the context in which they will operate, and should consider this to be as important as the design of the technical solution. Feedback mechanisms should be defined in specific stages, with a view to ensuring the smooth operation of the process and the suitability of partial results. Finally, the approach should be geared towards the user, offering a service-oriented perspective of the projects instead of a technology-oriented one.

The objective of the present thesis is to propose a model for TST systems as well as a systematic approach to their analysis, design and implementation, in an attempt to provide solutions to some of the problems described above.

For this purpose, I have developed an approach following the principles of Systems Engineering (SE) methodology (Hall, 1989; Leyzell and Loucopoulos, 1989). Bearing in mind the human and social aspects of the problem under investigation, a Soft Systems Approach (Checkland, 1981; Checkland and Scholes,

1990) has been specifically adopted. However, constant consideration should also be given to the final technological decisions, and the 'hard' techniques that usually guide such decision-making processes.

The development of systematic approaches is not new in the field of education. One of the most important areas of research in this field has been that of Instructional Systems Development (ISD). The next section deals with basic concepts in this subject together with lessons learned, in order to emphasize the advantages associated with adopting this type of approach in the scope of TST.

1.2. The Need for a Systematic Approach to TST: Lessons from ISD

The benefits of developing systematic approaches have been largely proved in other areas of the educational milieu. In particular, the advent of Instructional Systems Development (ISD) procedures has significantly changed the concept of training programmes and their effective implementation in organizations. Kauffman (1987) provides a broad definition of ISD as: *"...a process by which needs are identified, problems selected, requirements for problem solutions are identified, solutions are chosen from alternatives, methods and means are obtained and implemented, results are evaluated and required revisions to all parts of the system are made so that the needs are eliminated"*.

Long-established, recognized models and methodologies such as the ones developed by Gagné (Gagné, 1977; Gagné and Briggs, 1992), Romiszowski (1981), Dick and Carey (1990) or Buckley and Caple (1990) share the following set of characteristics that constitute the basis of ISD approaches:

- **Systemic view of the phenomena** - the object of study should be regarded as "a whole which functions as a whole by virtue of the interdependence of its

parts" (Buckley, 1968 in Buckley and Caple, 1990). The definition of the components of the system and of their interaction is the most important aspect to be considered from this perspective.

- The use of engineering approaches - engineering methodologies lend a systematic character to the ISD process by prescribing a detailed action procedure. The central stages in the process are the use of modelling techniques as a way of illustrating the system under study in its relevant dimensions, the creation of alternative design solutions and the provision of criteria for the selection of the optimum solution in the light of pre-defined objectives.
- An increase in the resources devoted to the initial analytical stages of ISD projects is being contemplated. Applied research in this area shows how careful consideration of the organizational needs is translated into a higher degree of acceptance on the part of the users, and consequently, into a better performance by the system.
- Another matter of concern regarding ISD approaches is the central role that human performance factors play in the selection of the design solution. In this sense, task analysis methods have become essential as they form the basis for further design activities in the system (Buckley and Caple, 1990; Dick and Carey, 1990).

Since the start of ISD experimental work in the time of the Second World War, application results have pointed to a number of benefits for organizations. These advantages were listed and discussed by Hannum and Hansen (1989), and are the following:

From a practical point of view:

- the application of ISD in different environments (Hannum and Briggs, 1982, discussed in Hannum and Hansen, 1989) has shown a significant increase in achievement, as well as a considerable reduction in training time,
- the systematic approach gives the manager a larger degree of control over the process, and improves the operation of interdisciplinary project teams,
- the control established during the design and implementation processes brings about reductions in cost, especially during the development and installation of materials, and
- goal-oriented evaluation is planned in ISD, and structured by the planning and validation of intermediate deliverables. This is translated into a "formative-like" evaluation approach to the process, with the subsequent benefits of enriching the information during the design process and later adapting the final product as much as possible to the proposed objectives (Flagg, 1990).

From a research point of view:

- ISD allows the creation of a framework which acts as an 'umbrella' under which contributions from different disciplines can be assembled,
- it provides greater accountability and comparability of results arising from different experiences, and
- it expands knowledge in this field by providing organized thinking on how systems operate.

This kind of systematic approach is becoming more extensive as innovations are introduced into areas of training (Morgan, 1987). Specifically, the use of information technologies as a support to educational activities, involving computer experts and engineers, demands some sort of systematic approach to the design and development of optimal solutions adapted to the needs of organizations and individual users. The application of these approaches in

innovative areas, such as Electronic Performance Support Systems (EPSS), as a reliable aspect of effective implementation, is giving rise to new models which are undoubtedly expanding the knowledge base in this field (Witt and Wager, 1994).

1.3. Requirements of a Systematic Approach to TST

Coming back to the problem situation addressed by this work, once the benefits of the development and use of systematic approaches have been discussed, there are a number of requirements that the TST systems approach has to fulfil if it is to deal effectively with the problems stated in the first section:

- It should provide a comprehensive, holistic view of the system under study, carefully taking into account key organizational, technical and human issues which may not only affect the system but which can also be affected by it.
- It should provide a modelling technique capable of describing in relevant terms the human activities that are to receive technological support. This requirement permits non-technological practitioners to communicate properly with technical implementors, and to elaborate the final solution to be adopted. Conversely, this type of modelling, if taken as a substantial stage in the design process, would help technology professionals to bring the technical design close to the human activities involved in the system. Both of these developments would meet the aim of preventing technology-driven decisions at early stages of the TST design process.
- It should offer a procedure for considering the analysis, design and implementation of an interrelated group of Adoption Strategies, in parallel with a more technical study, with the aim of trying to get people to actually

use the medium, become aware of its functionalities and benefits and eventually incorporate them into their normal activities.

- It should be useful as a tool both of design and analysis, thus facilitating the creation of new systems as well as the evaluation and maintenance of those already existing.

The present work tries to meet this challenge by presenting and testing out a systematic approach to the design and implementation of Telecommunications-Supported Training (TST) systems, the ADAM (Architectural Design and Adoption Model) approach. It serves as a basis for research into the problems and benefits of this type of method when coping with real-life situations, as well as for exploring its application potential.

1.4. Research Questions

It has generally been stated that the development of a systematic approach has two main benefits from a research point of view (Hall, 1989; Branson and Grow, 1987): on the one hand, it offers a procedure that helps to solve practical problems in the real world; and on the other, it serves as a research instrument, shedding light on the problem it is helping to sort out.

The Research Questions that will form the background to the development of this thesis cover both of these perspectives, firstly by dealing with the definition of the problem we face, that is, Telecommunications-Supported Training Systems, and secondly by exploring the development of a systematic approach to these systems.

Specifically, the work revolves around the following Research Questions:

- *How can a TST system be defined from the perspective of a systematic approach?*
- *How can a TST system be systematically designed in the real world? What would be the requirements and elements of such a systematic approach?*
- *Can the same approach be applied in analyzing TST systems that already exist? How should the approach be used in this case?*

1.5. Method of Work

1.5.1. The Development of the ADAM Approach

The ADAM approach has been developed on the basis of Systems Engineering methodologies (Hall, 1989; Miser and Quade, 1985; Layzell and Loucopoulos, 1989), while taking into account the social, human activity nature of the TST system (Checkland, 1985; Checkland and Scholes, 1990), and therefore adapting the method to these characteristics. The approach has been developed through the following stages:

- Description of the philosophy and the basic assumptions underlying the approach
- Development of the global TST system model
- Definition of the design requirements and evaluation criteria
- Elaboration of the ADAM modelling orientation and techniques
- Description of the application scope of the approach
- Design of the approach

The design of ADAM is discussed in detail in Chapter 3.

1.5.2. The Testing Out of the ADAM Approach

The ADAM approach has been tested out by using a case study methodology. Nowadays, the value of such methodology is widely recognized in the field of education. The work by Merriam (1988) offers one of the best rationales for adopting this sort of method. In the present work, the three factors applicable are those addressed by this author as the key to making a decision to adopt a case study approach:

- The nature of the research questions, and their suitability in carrying out an experimental, historical and descriptive design.
- The limited control over the variables under study, because of their psychological and social nature.
- The desired product of the experimentation, in this case a description of a process and its effect in order to demonstrate the validity of applying a new methodological framework.

The testing of ADAM will be carried out through studying the following systems:

- The Multimedia TeleSchool project of the EU and the TST system it has produced will illustrate the power of the ADAM approach to analyze already existing systems and to suggest alternative TST architectures that improve results of the system. This study will be accompanied by data from the implementation of MTS in two different corporate organizations.
- A detailed account and discussion will be set out, describing the implementation by the author of this thesis of a TST system at the Universidad Politécnica de Madrid, again by applying ADAM. This case

study will show the power of the approach to design a TST system in an educational context.

The problems and advantages arising from both application exercises in real contexts will be discussed in the corresponding chapters.

1.5.3. Data Gathering and Analysis

As for the two case studies, data will be analyzed collected by questionnaires, in-depth group and individual interviews, and observations made by the author and the project team, either as part of the Multimedia TeleSchool evaluation team, or as project manager of the Educational Telematics programme at the Universidad Politécnica de Madrid (UPM). Data concerning the implementation of the MTS system at the Deutsche Bundespost Telekom have been taken from the assessment report carried out by the Wissenschaftliches Institut für Kommunikationsdienste (WIK, 94), task manager of the MTS evaluation team.

1.6. Summary

The purpose of this chapter has been to establish the need for a systematic method of analyzing, designing and implementing Telecommunications-Supported Training (TST) systems, and to set out the requirements that such a method should fulfil. The problem situation has been described by referring to the factors missing in the literature, both from the point of view of research and of practice in the field of TST. In order to meet this deficiencies in an integrated way, I have proposed the development of a systematic approach to the analysis, design and implementation of TST systems. The discussion of a previous well-established, widespread application of such an approach in the field of education, that of

Instructional Systems Development, illustrates the conceptual basis of our approach and shows the benefits that this development can bring. Finally, the method of work followed in the thesis has been outlined, regarding both the development of the approach and its testing out in two different real-world situations.

Chapter 2

A Review of the Contributions made by Research Literature

2.1. Introduction

2.2. Information Systems Methodologies as Forerunners

**2.3. Adoption Strategies and Innovation Research: how to Cope with
Human Reluctance to Change**

2.4. Disciplines Contributing to the Study of Adoption Factors

2.5. Research Projects in the DELTA Programme of the EU

2.6. Conclusions

2.1. Introduction

The core of the present thesis, as stated in the previous chapter, is the development and testing out of a systematic approach to the design and implementation of Telecommunications-Supported Training (TST) systems. The learning applications of this kind of technology are quite recent; in fact, Information Technologies are in general very new, and furthermore, the rules of 'good practice' in educational applications have been difficult to state even for much simpler and well-established media.

The purpose of this chapter, then, is to categorize and critically review relevant research works that (i) are claimed to have contributed as forerunners to the field of TST design and implementation methodologies, and (ii) are similar in scope and reflect the state-of-the-art in this field.

It is important to remark at this point that, during a search carried out on the databases at the Educational Resources and Information Center (ERIC) and the International Centre for Distance Learning (ICDL), no explicit reference was found for publications that present a systematic approach such as that intended for ADAM. This means that the application scope of Telecommunications is at a very early stage of development and, consequently, the direct basis for this work is still limited.

Conversely, in terms of the contribution of other disciplines to the field of TST, the review is by no means exhaustive. The intention here is rather to illustrate how similar work in other types of human applications has yielded valuable results and recommendations which can benefit this research from a methodological viewpoint. This approach is justified on two counts: firstly, the scope of Technologies for Education has a highly interdisciplinary character; by contrast, even if there has been a lot of discussion and experimentation, the short life of the TST milieu means that there is no well-established research tradition to rely on.

The structure of the review is shown in Figure 2.1 and covers the following lines of research:

- The field of Information Systems (IS) methodologies has contributed the first systemic and systematic approach to the question of how to introduce technologies into organizations in order to support human activity. Obviously, there is no educational purpose behind these systems. However, the long methodological research tradition, on the one hand, and the results obtained in terms of users' reactions and organizational impact, on the other, make up a

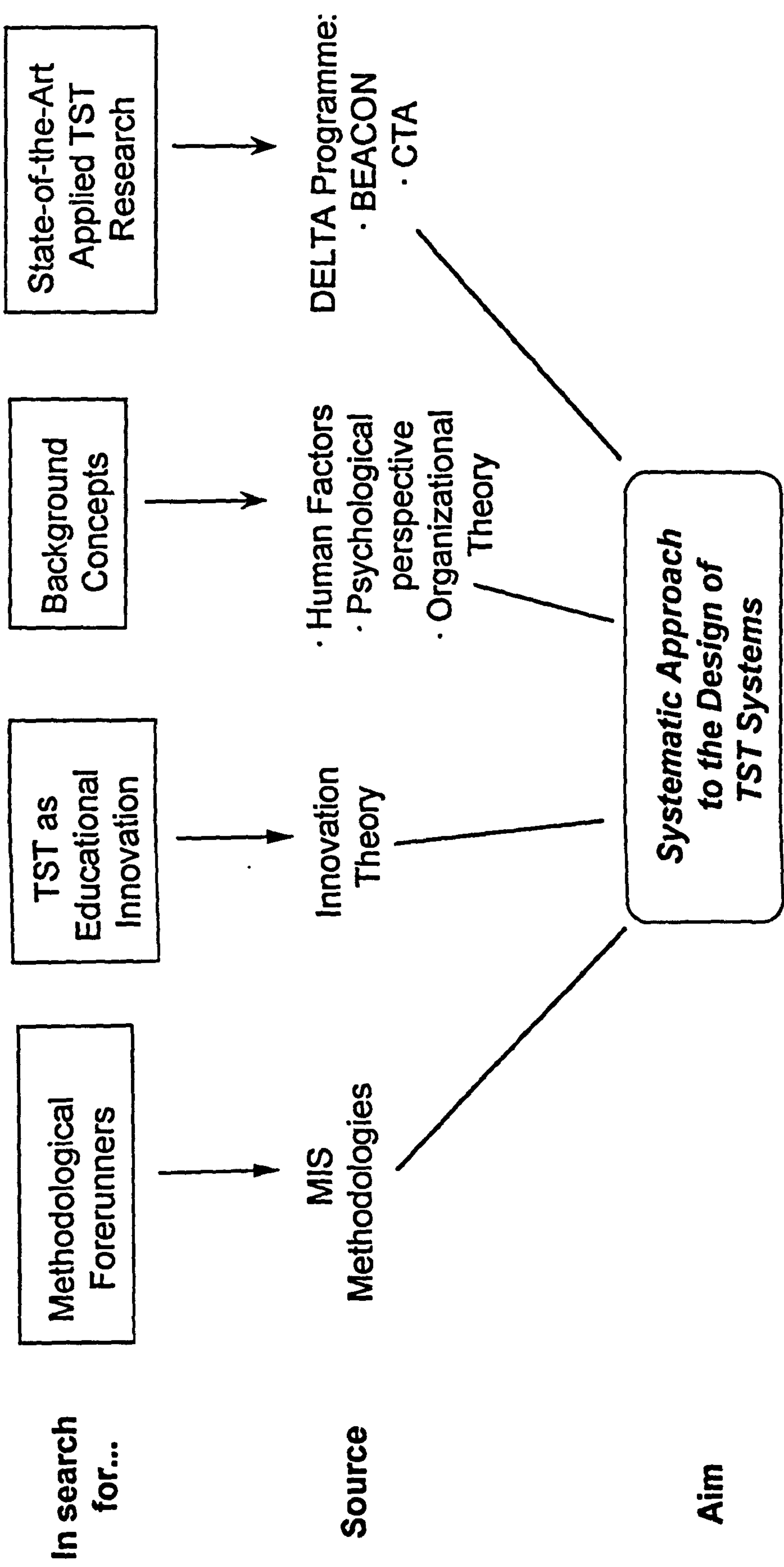


Figure 2.1. Structure of the Literature Review

very valuable input when this work is considered from our particular, practical angle.

- The implementation of Telecommunications as a support to human activities usually represents a totally new universe of experience for users in organizations; in this respect, recommendations have been made from Innovation Theory, suggesting strategies to get people to adopt and actually use the new systems.
- A group of contributing disciplines are briefly described, for they are claimed to constitute the background to the study of how to introduce technologies as a support to human activities. These are the theories on Human Factors and their contribution from the technical development point of view, the Psychological Approach and its influence on usability factors, and Organizational Theory dealing with the social and organizational aspects of the use of this technology.
- As far as the educational applications of Telecommunications are concerned, the DELTA programme of the EU is probably the best reflection of the current state of the art of research in Europe. Some of its specific projects are making contributions to the field of design and implementation of technologies for education which merit discussion in this section.

A structured research basis for this methodological work will come out of this analysis, as well as a discussion of the aspects in which the present thesis is a unique contribution to research literature.

2.2. Information Systems Methodologies as Forerunners

The rapid spread of 'third generation' computer applications during the 1960s favoured the flourishing of models and theories analyzing 'good practice' in the management of information in organizations. The large investment that the purchase of computer equipment involved in those times justified the need for procedures that guaranteed the efficient use of the system.

An Information System (IS) (or a Management Information System (MIS), since there is usually an overlapping of both terms) is conceived as "the mechanism which provides the means of storing, generating, and distributing information for the purposes of supporting the operations and management functions of an organization." (Layzell and Loucopoulos, 1989). The words 'supporting' and 'functions' mark the parallelism with the concept of TST as it is conceived in this thesis. The objective in designing IS methodologies was to transcend the craft procedures followed to develop IS, and structure and validate the process through the application of engineering principles and techniques.

What is the similarity between the MIS and TST systems? Both emerge from the need to introduce technologies in organizations in order to improve different areas of human performance. A research tradition of nearly 40 years in MIS has given rise to important lessons to be learned by any practitioner trying to make people adopt technology-based support in their activities.

The Information Systems Development (IS Development) methodologies flourished during the 70s, with a view to providing a systematic, stepwise framework for such developments, capable of being controlled and monitored. They usually consisted of a set of well documented procedures, with a rigid

structure and largely focused on the computer product they were to generate. A typical design followed the stages shown in Figure 2.2; a highly sequential structure with one single feedback loop going from the review stage to a new specification phase.

Extended examples of this kind of methodology are Structured Analysis, Design and Implementation of Information Systems (STRADIS) (Gane and Sarson, 1979), Structured Systems Analysis and Design Method (SSADM) in different versions (Downs et al, 1992) and Information Engineering (IE) (Martin and Finkelstein, 1981) (collected in Avgerou and Cornford, 1993). A comparison of the structure of several popular methodologies is presented in Figure 2.3.

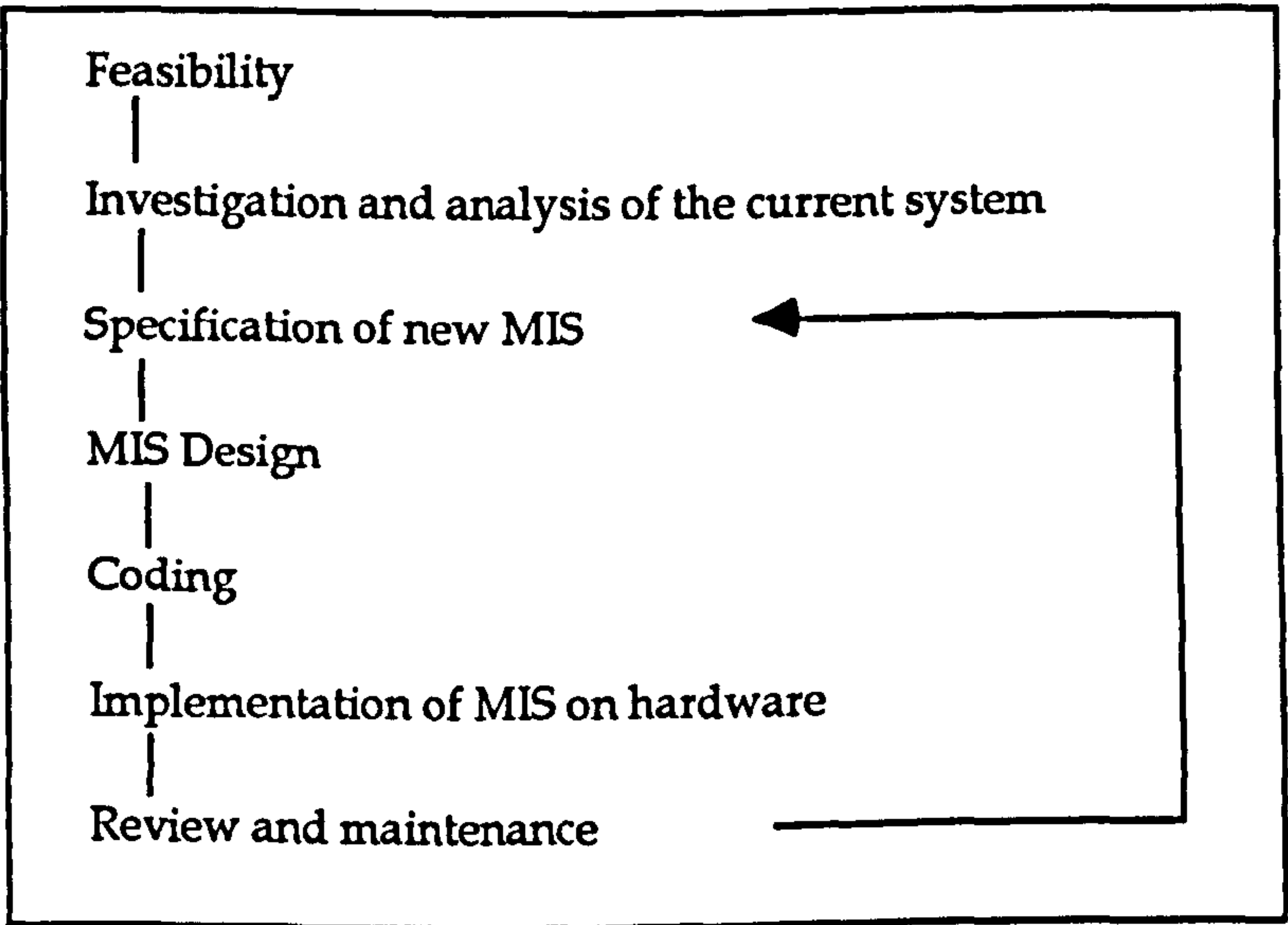
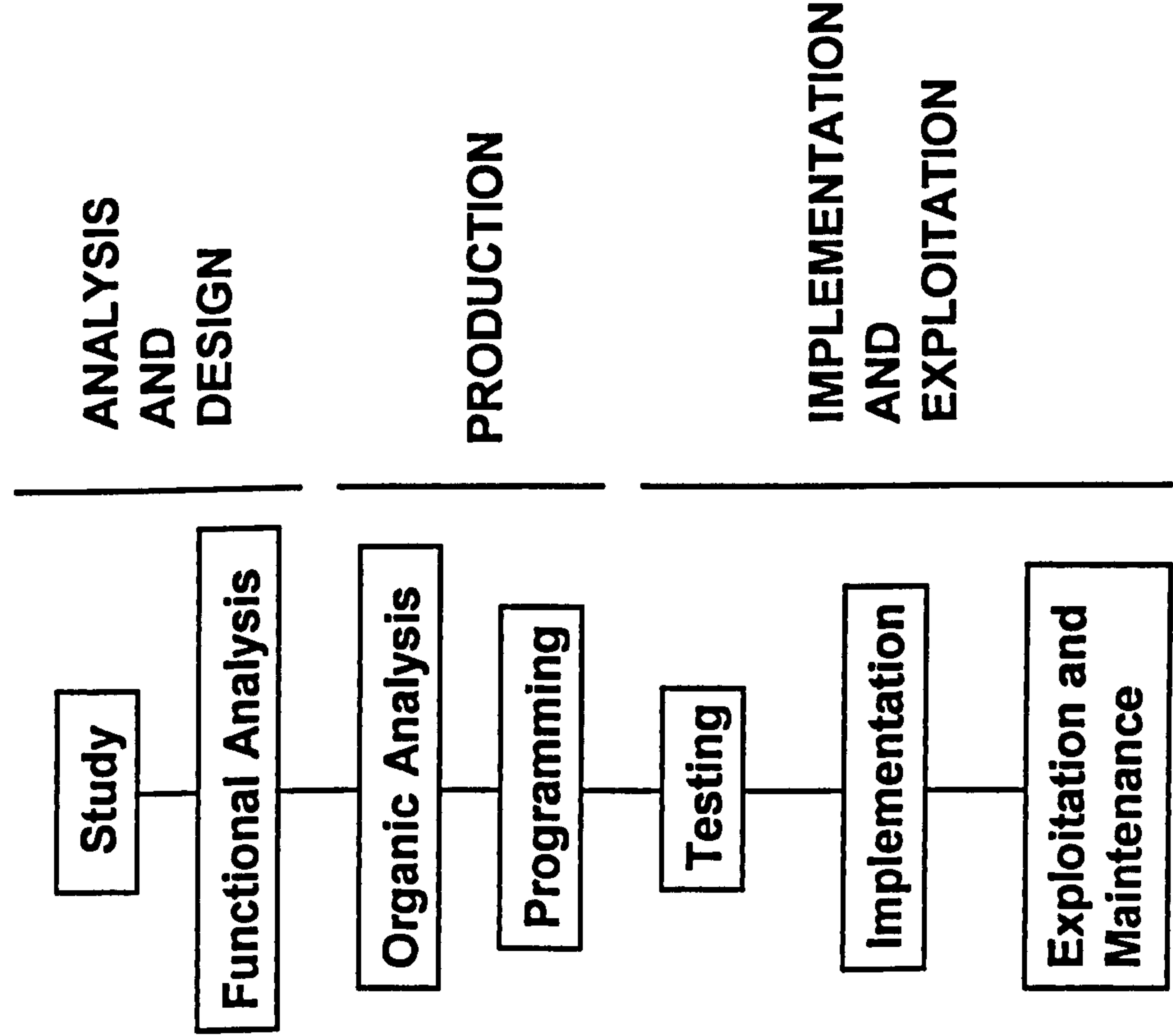
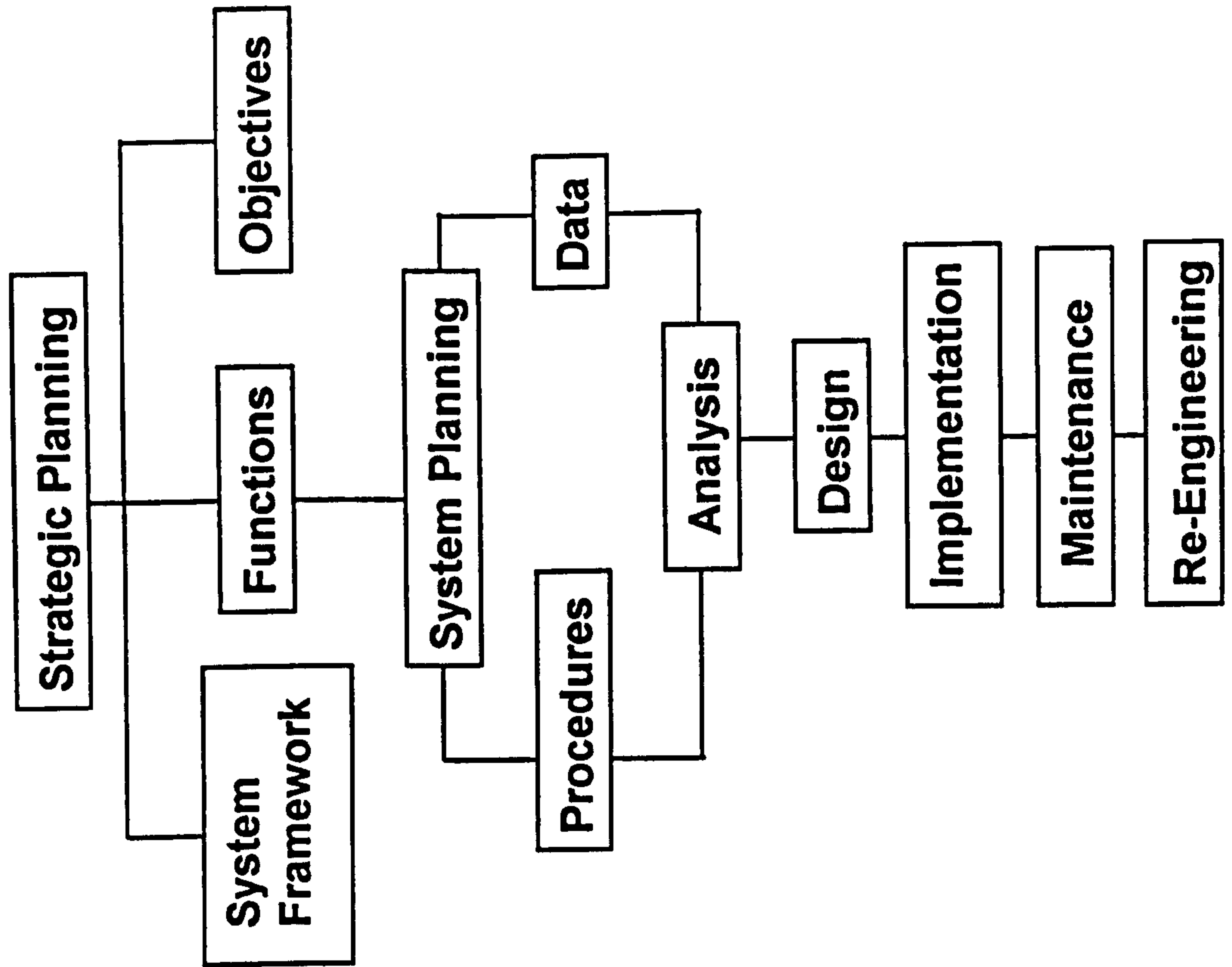


Figure 2.2 - Process outlined by structured MIS methodologies

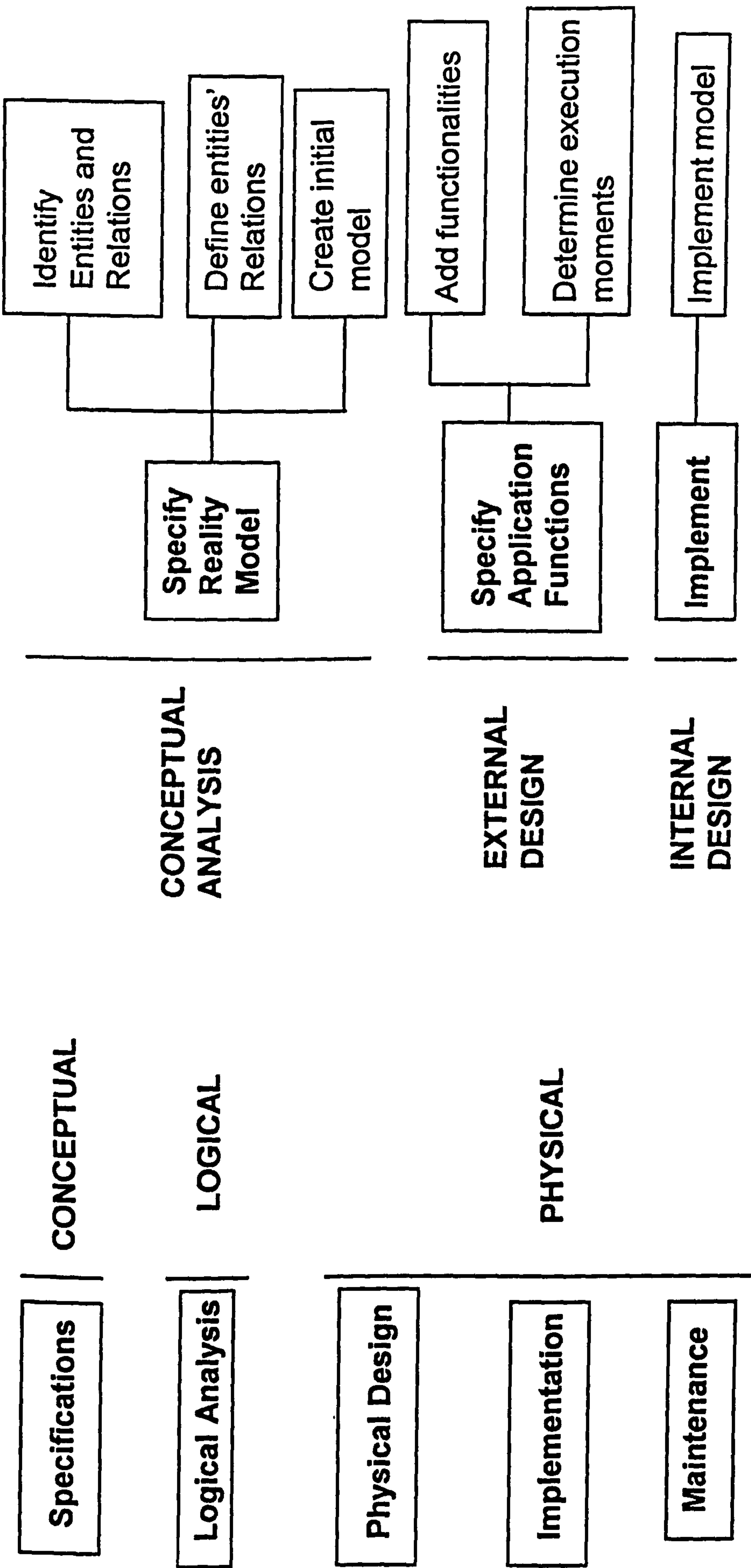
This type of structured methodology has dominated the last 20 years of research in this field. An annotated compilation by Olle et al. (1991) lists more than 30 different published methodologies used in academic and commercial organizations. The work of Avgerou and Cornford (1993) made a critical analysis



Traditional Development Stages



Martin's development model



Yourdon's model

Jackson's model

Figure 2.3. Comparison of different methodologies (II)

of the work in this field in an attempt to bring together and study what they called the "methodological movement".

The direct relationship of ISD with its technological components has greatly affected the underlying principles of the methodologies, however. IS projects have been dominated by technologists, thus placing the emphasis on software developments and hardware implementations rather than on the further uses of the final product. This, in fact, has been the major objection stated by researchers when evaluating IS, and experimental results from the use of such methods strongly support their claims. Several studies point to the fact that the use of structured methodologies has not increased productivity as quickly as was expected (Westrup, 1993; Avgerou and Cornford, 1993; Hirschheim and Klein, 1992). Some of the reasons stated for this lack of effectiveness include:

- The strong emphasis on the software/hardware product; the process was considered successfully completed when an error-free code was implemented in the machines, but this does not guarantee that the system will fit into the real situation in which it is implemented.
- The excessively strict structure of steps and activities (based ideally on 'paper and pencil tools') which has hindered both the creativity of the designer and also the consideration of a wider context for his/her activities.
- The lack of involvement of the final users during the design of the system.
- The low level of concern for the maintenance of the system, once implemented.
- The need to use more flexible tools which offer recommendations that may be adapted to the changing conditions of different organizations, rather than pursue rigid prescriptions.

The advent of databases and networking applications brought about a change in the design of IS systems, and a more global research approach has started to take shape. The concept of 'the IS system' has been replaced by 'the IT (Information Technology) strategy', referring to "the art of planning and managing the integration of IT into the enterprise to the best advantage, that is, to integrate technology with the objectives of the organization" (Wolstenholme et al., 1993). The IS becomes the support not only of decision-making, but also of administration, planning, office automation, general analysis and scientific functions within the institutions. This wider scope of the concept, as well as the extended use beyond individual managers, has important implications for incoming methodologies. Conversely, the step forward taken with technology to client-server models, object-oriented techniques and networked architectures is also bringing about major changes leading to a more comprehensive view of the organization for the design of IS (Sankar et al., 1993).

The following issues have characterized this change of approach, in contrast to traditional, structured methodologies.

a) Methodology: Prescriptions or Guidelines?

This change of outlook set specialists to search for alternative methodological paradigms. For instance, a less prescriptive, more flexible approach has been adopted by Hirschheim (Land and Hirschheim, 1984; Hirschheim and Klein, 1989), one of the more radical detractors of the indiscriminate implementation of IS Development applications. The main value of a methodology, according to this author, lies in conferring authority to the developer in the organization, in the absence of qualified IS professionals; but in practice, instructions are not followed, and the only guarantee of control is the completion of the milestones

contemplated in the documentation. This does not mean that a systematic approach should not be adopted, or that structured methodologies should not be used. But the way to extract valid data regarding the effectiveness of the methodology is instead to follow a longitudinal, case-study approach for every individual organization and to specifically adapt prescriptions to their particular context.

The statement that organizations do not actually come to use the methodologies but just adapt them to their own interests has received considerable experimental support. A set of studies carried out by Sakthivel (1992) shows how the priorities estimated by practitioners and researchers in IS methodologies in terms of effectiveness do not coincide; in fact, initial stages of analysis are considered too long and costly to be exhaustively followed. In a different study, Westrup (1993) basing his opinions on the analysis of two case studies, concludes that perhaps a "methodology for the use of IS Development methodologies" would have to be developed, since such techniques cannot be uniformly used but rather adapted to the interests and conditions of every organizational context. As Avgerou and Cornford (1993) have put it:

"While methodologies seek to offer comprehensive advice on how to develop information systems, we need to be aware that every situation is unique, yet a unique approach every time is equally unhelpful even if any approach tailored to the situation can share some tools and techniques." (p.282)

Structured methodologies are claimed to be too rigid and therefore limit the creativity of the professional in this adaptation. They seem to be useful in helping the novice practitioner, but not so much in the cases of experienced users, who can

transcend the instructions and go further towards innovation while addressing their own organizational goals (Hales, 1991).

Consequently, given the complex organizational and social context in which they have to be applied, the best methodologies seem to be those providing a set of guidelines which offer assistance during critical decision-making stages, rather than strict, prescriptive methods that prove more difficult to adapt to particular situations.

b) The Socio-technical Approach: Soft Systems Methodology

The work of Checkland (Checkland, 1981; Checkland and Scholes, 1990) and the school of Lancaster have had a significant influence in changing the approach to the new IS methodologies (and to the Systems Theory in general). Coming from the field of Operational Research, their work stems from the premise that traditional systems engineering is not applicable to 'ill-defined' problem situations, which exist in practically all the fields of human and social behaviour. 'Human Activity Systems' are characterized by people in social roles trying to take purposeful action. This 'pursuing the purpose of the whole' means that a mechanical design approach is no longer possible; instead, it has to be replaced by the analysis of multiple world views, in which social and technological factors are deeply enmeshed.

A thorough description of the principles underlying Checkland's Soft Systems Methodology (SSM) is well beyond the scope of this work. The next chapter will come back to this research area in more detail. For our purposes, however, it will suffice to say that the SSM approach has opened new paths in the consideration of social and organizational aspects of the design of Information Systems. It has

offered a more open, less strict formalization of the methods, in understanding methodology as "a set of principles which guide action in trying to 'manage' real-world problem situations in the broad sense " (Checkland, 1990). This definition has had implications for:

- the consideration of a wider context for the design of IS applications, and
- the increasing application flexibility of the methodological procedures

This perspective has been adopted as a research position from a cognitive viewpoint by authors such as Galliers (1993) who states that the design of IT-based systems should take into account the individual user and the value he/she attributes to data coming out of the system in order to take purposeful action.

c) Users' Involvement

The majority of researchers have agreed on the need to involve future users of the system from the earliest stages of the process. Briefs, Ciborra and Schneider, in the introduction to the compilation "Systems design for, with and by the users" (1983) postulate the strong need to involve users for two main reasons:

- to gain a multi-dimensional, realistic view of the system under study, and
- to increase users' motivation towards the system by making them feel an integral part of it.

This view has been shared by a large group of authors, who have proposed models and strategies to achieve this objective.

Hales (1991) proposes a human-centred model based on four strategies to guarantee a close relation between the final system and its future users:

- *Statement of principles*: one of the most common problems of methodologies in practice has been the tensions created among the partners involved in the development of aspects such as deadlines, planning, etc. This model states that there should be an initial negotiation among all the actors involved in the process. This should include an outline of the commitment that the organization intends to make in relation to budgets, for example.
- *Key management roles*: these should be defined at two different levels: the Information Resources Manager (IRM) comes from senior management, and is responsible for the development and delivery of the strategy. For their part, the Information Resources Officers (IRO) are from middle management, usually technologists. They receive the inputs about users directly from the IRM, in an attempt to guarantee the consideration of individual, group and organizational levels.
- *Study and design circles*: the core of the model is the participative design activity, with iterations going to and coming back from users and designers, in the form of meetings and workshops with the different stakeholders in the project.
- *Job design and human resource planning*: any IS system has to act as a support to people's activities, which may change over time. Therefore, these two factors have to constitute the basis of the IS design, in order to guarantee the fulfillment of organizational aims.

For its part, the work of Galliers has focused on the organizational and individual issues underlying the design of IS systems (Galliers, 1993; Galliers et al., 1994). He points to the need for arranging what are called "strategic information system planning workshops" with the users aiming at (i) getting technology closer to people from the beginning, and (ii) directly linking task requirements (as users see them) with technologies.

Westrup (1993), stressing a particularistic approach to methodological design, describes an interesting case study to illustrate how even those methodologies integrating strategies for user involvement cannot guarantee the success of the procedure. The case describes the implementation of an IS system at a nursing institution following a specific methodology which emphasized the importance of involving the final users from the beginning. A workshop was organized with a group of senior nurses in order to rank the preferred functionalities of the new system. During the meeting, it turned out that the nurses were unable to decide the priorities in the way stated in the documentation. In such cases, the prescription to involve users has to be followed, but not necessarily in the way stated by the methodology.

d) New Roles: the profile of a methodologist

It has already been stated that structured methodological models created the figure of the Systems Analyst as the specialist qualified to put their prescriptions into practice. This person was usually a technology professional, this being one of the main problems in implementing IS in practice. In this sense, Earl (1989) proposed the creation of a new specialist, called the 'hybrid manager', who would ideally have technical expertise but would also have a wide knowledge of the business organization in which the system were to be used. This manager, having

this kind of mixed profile, would be able to manage the project by combining and controlling information and technology factors in an integrated way.

In this sense, Hales (1991) suggested a team composed of the Information Resources Manager and several operators; in this case, responsibilities are split among different people, but it is the Manager who contributes the strategic view as well as dealing with the information and human factors involved in the project. Both views, therefore, give priority to the usability aspects of the system rather than to the technological ones.

Avgerou and Cornford (1993) comment, in their review of the 'methodological movement', that researchers agree on the requirement of an interdisciplinary team combining these different skills whenever the powerful role of hybrid manager cannot be taken up. In any case, as a study carried out by Clark points out (1992, cited in Galliers, 1993) in the context of high management views of IS support in their institutions, the activities regarding software development management are increasingly being outsourced, and therefore the internal technology role is becoming less prominent in the organization. The study also refers to the estimated shift in the function of the IS service from the development of systems to advice on the integration of the system into the organizational strategy.

e) The Problem of Maintenance

Together with the issue of users' acceptance, the problem of maintaining the system resulted in considerable criticism of the traditional methodological approach. The capability of an effective system to change throughout its life, adapting to organizational changes, has not been adequately dealt with in structured methodologies, which considered the process practically finished once

the system was installed and tested. New research trends claim that maintenance activities are of a different nature than those of implementation, and therefore need to be considered in their own right as a part of the design process.

Peculiarly, it has been the area of Software Engineering that has contributed one of the most influential models to make methodologies more flexible so that maintenance problems can be tackled. The work of Boehm (1981, 1987) presents a 'Spiral Model' in contrast to the traditional linear, 'Waterfall' one (such as that represented in Figure 2.2, for which one only feedback loop exists from the maintenance stage to a further new specification of MIS). The spiral consists of several iterations in which, for each part of the product being developed, the following process is carried out:

- the statement of objectives,
- suggestions for implementation alternatives with their respective constraints and limitations
- the evaluation of the alternatives (from which areas of uncertainty are identified)
- the formulation of a cost-effective strategy for dealing with the sources of risk: prototyping, quantitative analysis, simulation, etc.

The process involves as many iterations as necessary whenever the designer identifies a factor that can be improved or may require modifications. For this reason, the cyclic model is equally suitable to the implementation and maintenance processes, since both involve a testing of the reality hypothesis.

The spiral model is graphically shown in Figure 2.4.

This perspective implies the adoption of a risk-driven approach, as the author himself describes it, to the software development process. Boehm's model has greatly influenced the world of Software Engineering methodologies, given the high costs usually involved in these processes and the need to use resources as effectively as possible.

The growing integration of human and organizational factors involved in the implementation process is making researchers give recommendations on the high complexity of the environments in which IS methodologies have to operate (Avgerou and Cornford, 1993). It is precisely in this kind of uncertain context that a cyclic, iterative model acquires importance in giving rise to the discussion of different implementation alternatives with their associated risks and suggesting strategies to cope with such limitations, in a search for cost-effective solutions.

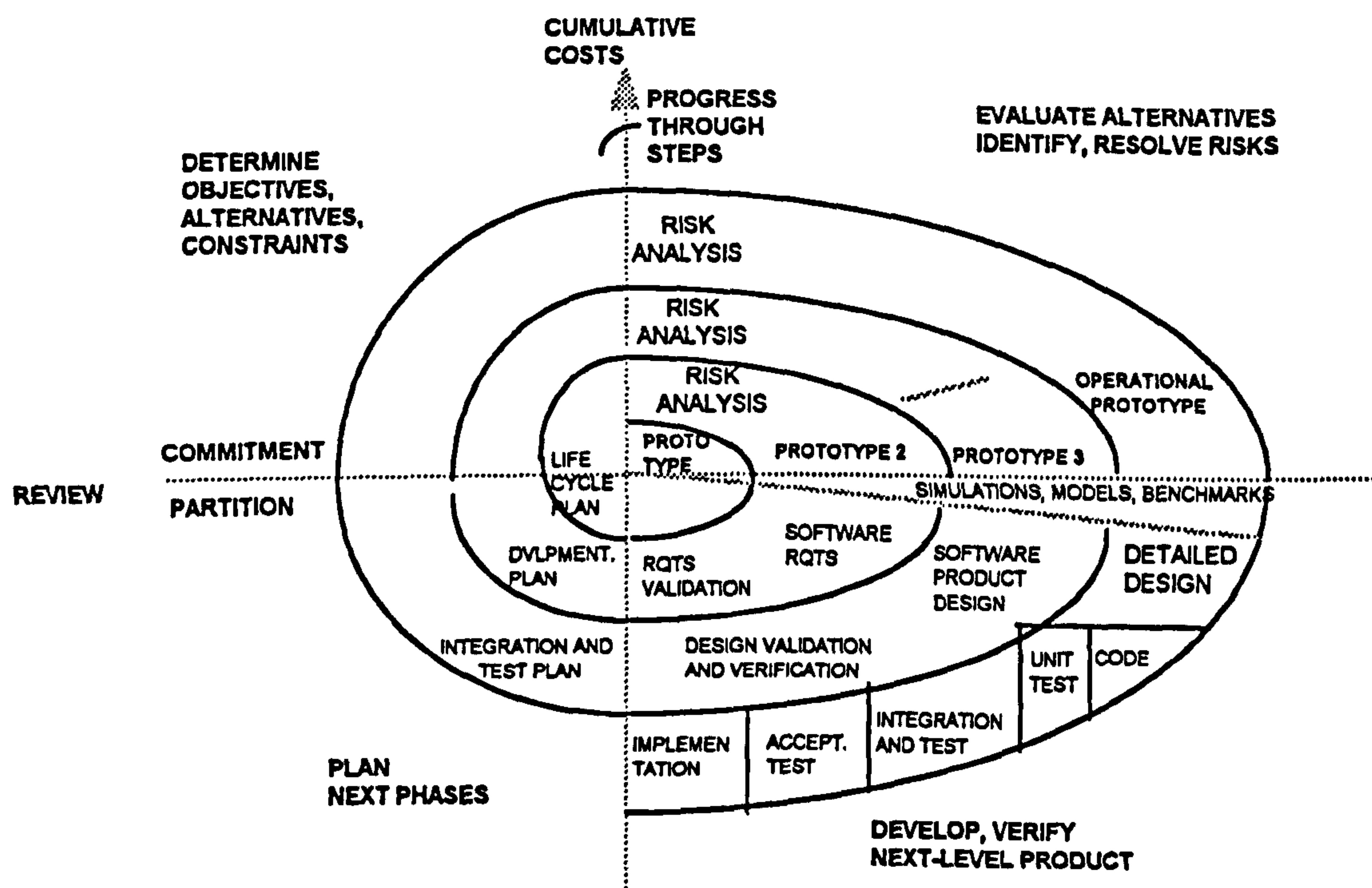


Figure 2.4. Boehm's spiral model for software development (1987)

The cyclic model has been adapted to several social applications; in this sense, for example, the work of Kolb (1973, cited in Boehm, 1981) has been remarkable in the field of organizational learning.

2.3 Adoption Strategies and Innovation Research: how to Cope with Human Reluctance to Change

The field of Diffusion and Innovation research also opened up in the late 60s and has experienced a dramatic growth in recent decades. Works in this area attempt to shed some light on the processes by which individuals and organizations become acquainted with an innovation and eventually incorporate it into their lives, with the corresponding social and behavioural changes.

The work by Rogers, from Stanford University, is probably one of the most representative in this area. Rogers published his first book "*Diffusion of Innovations*" in 1962, and the most modern and revised edition of the book in 1983 still keeps to the same principles, after having received empirical verification during all these years.

A central concept in Rogers' work is that of Adoption, which is "*...a decision to make full use of an innovation as the best course of action available*". (1983, p. 27) The process of innovation-decision, that can eventually lead to adoption by the user, is structured by Rogers into five stages:

- *Knowledge* - the individual is exposed to the innovation and consequently becomes aware of its existence and basic functioning,

- *Persuasion* - consists of the generation of a positive or negative attitude towards the innovation
- *Decision* - the performance of activities leading to a choice to adopt or reject
- *Implementation* - the individual puts the innovation into use
- *Confirmation* - once the decision is made to adopt, the individual can search for reinforcement for such a decision, with the associated risk of changing his/her mind.

The process of innovation-decision can lead to three different results: Adoption of the innovation, Rejection of the innovation, or Discontinuance, that is, to drop out after an adoption decision has already been made.

Rogers suggests strategies that should be used by an Innovation Change Agent in order to succeed in the Adoption process, such as the correct choice of initial information to be provided to users so that they gain awareness and adopt positive attitudes in the early stages of their decision. He also raises essential issues like the problem of adopting an innovation when no clear need for change is perceived by potential users in a given context (usually the case with educational projects), and the influence of networking in the diffusion process. Another thought-provoking concept is Re-invention, defined as the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation, making reference to the dynamic character of the innovation-decision process, and consequently placing the emphasis on psychological and social factors.

Rogers offers a comprehensive and integrated framework for the study of the diffusion of innovations, profusely illustrated with case studies in several application areas. A taxonomy of the categories of adopters is also proposed in

relation to interaction factors (active vs. passive adopters) or the level of involvement in the diffusion process (early to late adopters).

As in the former discussion on methodologies, it would not make sense to describe Rogers' framework extensively in this section. Instead, it is more appropriate to comment on other works influenced by his framework. Very close to Rogers' research school, Clark and Staunton (1989) proposed a strategy model for the adoption of innovations which consisted of the following stages:

- Awareness
- Interest
- Evaluation
- Trial
- Adoption

Coming back to the IS field, several authors have established strategies to set users on their way in adopting a technological system. Silver and Silver (1989) proposed including the following steps in the implementation process:

- Announce the new system formally, as well as its implications for the organization
- Involve all levels of personnel early on
- Stress the benefits to be gained from the implementation of the system
- Give a progress report to the users periodically
- Encourage positive support

For his part, Fried (1992) laid down the following guidelines for avoiding acceptance problems:

- Limit the scope of change to small-scale pilot experiences in the early stages.
- Inform all affected employees of existence of the system (even if indirectly), within the context of organizational benefits, so that they value the change appropriately.
- Ensure management commitment and keep managers informed of progress
- Ensure the continuity of the project (avoid interruptions) and maintain consistency.
- Gain participants' cooperation by seeking assistance from key members of staff and set up a help and coordination desk for the project.

Finally, a model proposed by the University of Minnesota Telecommunications Development Centre is of special interest here, for it focuses specifically on the field of Telecommunications innovations in training settings. The work by Morehouse and her team (Stockdill and Morehouse, 1989; Morehouse and Stockdill, 1991; Stockdill and Morehouse, 1991; Lee, 1991), also relying on Rogers' principles, proposed a Technology Adoption Model, shown in Figure 2.5, in which five factors are defined as critical to the successful adoption of the technology: Educational need, User characteristics, Content characteristics, Technology considerations and Organizational capacity. The model is staged into:

- front-end Analysis
- Prototype Development
- Small-scale implementation
- Organizational Adoption
- Institutionalization

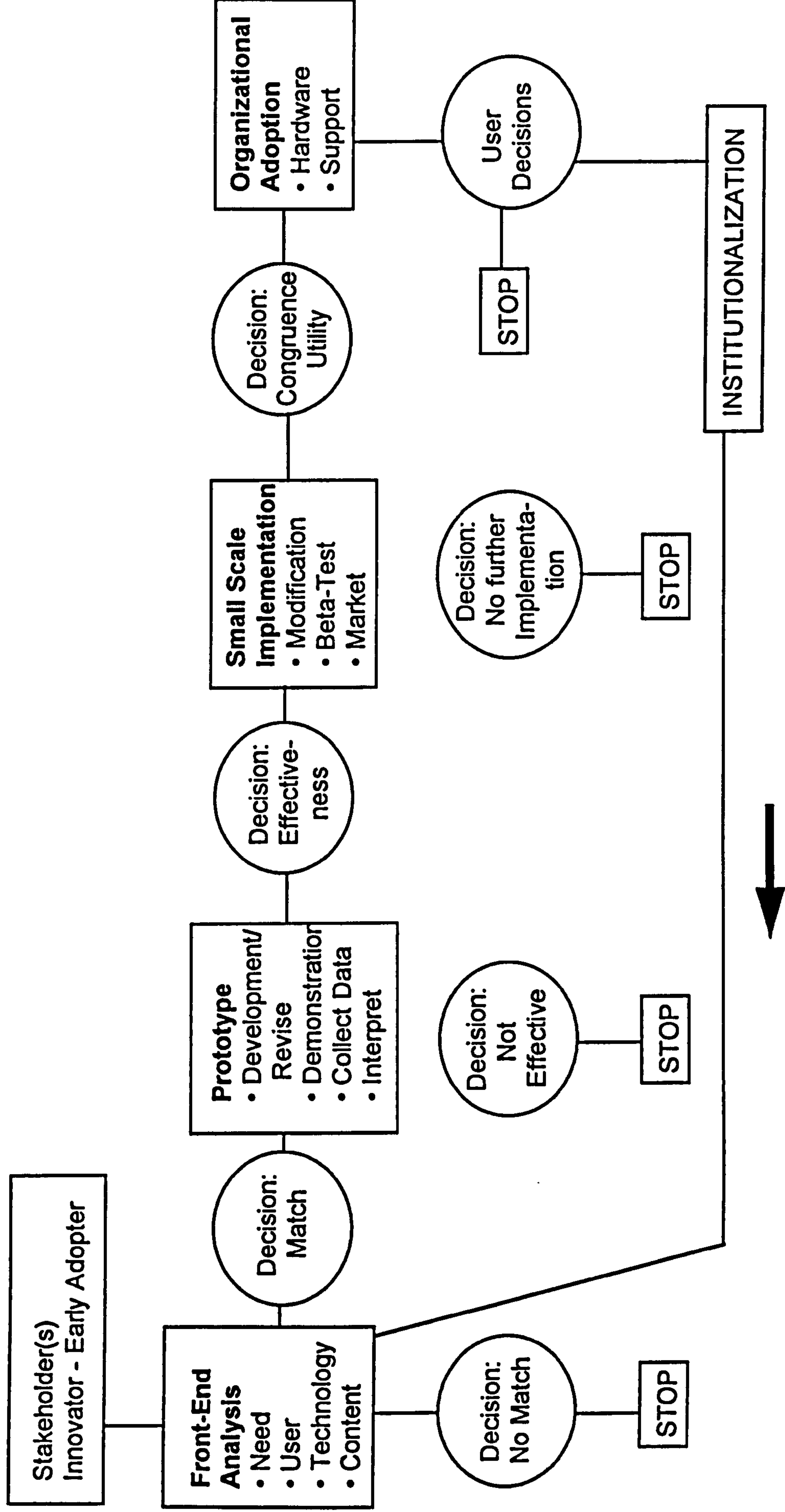


Figure 5.7. Technology Adoption Model (Morehouse and Stockdill, 1991)

As can be observed in the figure, the model takes an incremental approach to the institutionalization process; a prototype is designed as a result of the front-end analysis of the previously mentioned factors, and if it is considered effective, further small-scale implementations are recurrently designed until broad organizational measures (mainly in terms of investments) are made. The model has been successfully tested on several innovative educational projects (involving CAL, Satellite Videoconferencing and Interactive Videodisc) at the Minnesota Extension Service during the last few years.

2.4. Disciplines contributing to the study of Adoption Factors

Many different disciplines have contributed to the study of Adoption Factors, providing different viewpoints and yielding interesting results. Three of these subjects will be examined in this review:

- The field of Human Factors Theory
- Psychological perspectives on Acceptance Factors
- Organizational Theory and a macro, social approach to the Adoption of Innovations

2.4.1. Human Factors Research: Users' Feedback and Technology Design

The study of Human Factors and their implications for technological developments has seen important changes since the early stages of pre-information systems. Initial conceptions of Human Factors were built around mechanical principles, from the Taylorist approach to Human Resources, the

worker was conceived as a source of power (Carey, 1988). The Second World War and the sort of technology generated by the defence industry brought a more modern conception of people having to apply cognitive skills to the use of new machines and devices. The arrival of Electronic Technology, and the consequent emerging Cognitive Science demonstrated the need to consider other kinds of human abilities, such as perception, decision-making and problem solving, incorporating them as a source of feedback in hardware and software design.

An appropriate definition of the field of Human Factors was provided by Woodson (1981) (in Beard and Peterson, 1988):

"The practice of designing products so that the user can perform required use, operation, service, and supportive tasks with a minimum of stress and a maximum of efficiency. To accomplish this, the designer must understand the needs, characteristics, capabilities and limitations of the intended user and design from the human out, making the design fit the user instead of forcing the user to fit the design"

Many taxonomies have been proposed stating key issues from this discipline. Beard and Peterson (*op.cit.*), for example, consider five main categories:

- *Man-Machine Interaction* - use of keyboards, mouse, touch screens, etc.
- *Interface Specification Tools* - methodologies for formal design of the interfaces
- *Information Presentation* - how the data is represented to the user
- *System-User Documentation* - design of manuals, references and support materials
- *End-User Involvement* - how to bring the user's perspective into the design process.

One of the most important contributors to the field of Human Factors, Brian Shackel, defines the term Usability as the core of research in this field (1991):

"the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios".

Such a definition goes beyond the previous one as it takes into consideration not only the user's characteristics but also the relationship with the environment in which the user is performing the task. The concept of efficiency thus acquires a more complete meaning. Another very interesting aspect of Shackel's theory is the claim for an operational definition of Usability in terms of goals and measurable criteria. Such a definition is divided into the following factors:

- *Effectiveness* - stated in terms of speed and errors, in comparison with other performance rates
- *Learnability* - specifying a time span, and defining materials
- *Flexibility* - the percentage of variation allowed in tasks beyond those specified
- *Attitude* - within acceptable cost in terms of tiredness, discomfort, frustration and personal effort

An approach even closer to non-technical aspects is proposed by Damodaran (1991), in what she calls Human Factors Strategy. This approach very nicely combines technical aspects and organizational ones into a methodology for introducing Information Technology into organizations. In this case, the criteria covered are very much along the lines of Shackel's, but some new considerations are included, such as the need for a multi-skilled design team, and the importance

of the specific role of Human Factors Consultant to supervise the design, development and implementation process.

2.4.2. The Psychological Perspective:

How to Use Technology and What to Use it For

Another group of researchers, mainly from the field of Psychology, analyze the interaction between the individual and the technology from quite a different perspective. In this case, people are facing a new device; technology is perceived as an instrument to perform certain tasks, which in most cases have been traditionally carried out in a very different way. This more complex panorama raises a lot of questions for the user to consider in order to make a decision about his/her final interaction with the system. Adoption Strategies should address these questions so that the user can be assisted in making a decision in a positive and active way.

Davis (1993), basing his opinions on traditional Attitude Theory (Fishbein and Ajzen, 1975), proposed what he called the 'Technology Acceptance Model' (TAM). The nucleus of the model is the division of the concept of usefulness into two distinct variables: ease of use and usability from the user's point of view. Ease of use is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental effort", while usability is understood as "the degree to which an individual believes that using a particular system would enhance his or her job performance". Thinking in these terms, the construct of ease of use would be the major concern of Human Factors Research as has been shown. However, according to Davis, perceived ease of use has a causal effect on perceived usefulness, while the inverse does not hold. Moreover,

perceived usefulness is shown experimentally to have more effect on the individual's actual use of the technology than on ease of use. This means that, facing several technologies with different degrees of ease of use, people would not mind choosing the option which were less easy to use if they realized that it could be more useful for their own purposes.

This kind of theory casts a good deal of light on the Adoption factors and strategies to be developed. Within the framework of Davis' theory, for example, we can see the need for making users aware of the benefits and usefulness of the technology they are facing even before demonstrating its functioning. This would constitute scientific justification for one of the most popular statements from users in the field of Educational Technology: "*It's nice, but what is it worth?*".

A very interesting study of psychological factors affecting the usability of the technology has been made by Warburton (1993), in the context of developing user interface for the new client-server systems. This author refers to the 'Iceberg metaphor for usability' from a set of investigations carried out in Xerox laboratories. These studies pointed to the influence of an interface of three factors in the final usability: *presentation*, that is, layout and style (accounting for 10% of total relevance), the user's *opportunities to interact* with the system (30%), and the *conceptual model* underlying the development, that is, the satisfaction of the user's expectations of how the system works. This last factor is precisely the hidden part of the iceberg, but has to be sufficiently well represented through the other two factors, so that the user creates an accurate mental image of the use of the tool during a number of sessions with it.

Relying on this set of concepts, the work outlines a method for the design of user interfaces with a view to guaranteeing three conditions: (i) that the user controls

the tool, (ii) that the interface reduces to a minimum the user's memory workload, and (iii) that the interface is consistent.

The perspective adopted in Warburton's work assumes a complete reliance of usability on development factors. It is claimed that the way in which the user acquires the conceptual model is just by using the technology repeatedly. It should therefore be to the designers' credit if the balance stated by the iceberg metaphor is reached in order to make the familiarization process as painless as possible.

The design methodology developed by Warburton is a source of stimulating inputs for our work, in placing the emphasis on uniting psychology and technology. In fact, some of the questions addressed by the design are of the sort "What knowledge will remain in users' minds?". These are followed by a careful modelling of individuals and scenarios (similar to the creation of a movie-script) through permanent communication with the ultimate users of the future system.

Another set of theories from a psychological angle offers models along these lines. Remenyi and Money (1991) define 'satisfaction' in the context of MIS as the gap between the users' expectations of several attributes of the technology and the reported post-use performance of these attributes within the system. In some way, this measure represents the degree of 'disappointment' with the technology when compared to the expectations this has created. Very interesting results have been obtained from studies of evaluation of Information Systems in the light of this approach; an important lesson to be learned is that the individual should be considered to a greater extent when designing the system, as a complement to organizational goals. Greater information about the potential and functionalities of the technology should also be provided, so that users develop more realistic

expectations of it. Finally, this kind of method is proving useful in detecting problem areas, and should therefore be included as a part of the design and evaluation of technology supported systems.

Relying on a detailed study of users' expectations and perceptions, Nickerson (1981) carried out a study that generated one of the first classifications of Adoption Factors from a purely psychological perspective. In the paper "Why interactive computer systems are sometimes not used by people who might benefit from them", the author made an extensive study with a large sample of end users of technological tools in the context of Information Systems. As a result of the investigation, he states the following factors as the main characteristics of users' reactions:

- *Functionality* - the system is very impressive, but users do not find it helpful in their activities.
- *Accessibility-Availability* - users want the system ready and available whenever they need it and for as long as they consider necessary, and sometimes the system does not meet this requirement.
- *Start-Stop inconvenience* - it may take too long to get the process working, and the same can apply when stopping.
- *System dynamics and response time* - the system is found to be too slow (this is especially true for Telecommunications, in which computers and networks have an accumulative effect).
- *Work-session interruptions* - problems associated with the system throwing the user out because of a break-down or a network problem.
- *Training and user aids* - not fitting users' profiles and needs (especially on-line aids).

- *Documentation* - usually too technical, poorly organized, unclear, etc. A distinction between tutorial and reference needs is important.
- *Command languages* - Not direct and difficult to recall.
- *Consistency and Integration* - there is a need for the standardization of systems.
- *User conceptualization* - there is usually a lack of metaphor for navigation and for handling the system.
- *Miscellaneous - other factors* - resistance to change, fear of computers, social problems, etc.

It is remarkable that the factors stated in this study, carried out thirteen years ago, are practically the same as those affecting any implementor of technology-supported systems nowadays. It is true that technical advances have increased the standardization and integration of the interfaces; examples of this can be found in the rapid spread of iconic and windows-based interfaces, and the trend towards standard interfaces and applications in a few environments (Windows, OS/2, etc.). But the essence of users' complaints remains very much the same. Why has significant progress in this field not been made? Perhaps the key is the lack of methodologies or systematic approaches to the introduction of technologies, which could help practitioners to be aware of these problems well in advance and devote time and resources to search for strategies to tackle them adequately.

2.4.3. Organizational Theory: the Macro Approach

Research into organizational behaviour and changes has also yielded input to the study of critical adoption factors in providing a macro-context for the implementation of technologies. The requirement in this case is an organizational strategy that plans the effective long term use of new media and tools. This perspective complements the technical and psychological studies, in suggesting aspects that can mediate in the use of technologies by individuals in their work context and by examining the social relations that such a context engenders.

Wijnhoven and Wassenaar (1990), in the field of Impact Research, posed the following questions from a research point of view:

- What are the organizational changes required to introduce technology systems effectively?
- What will be the position of the new members of the organization? And what will happen to those already there?
- Is the organization better adapted to its environment as a result of the new system?

Other broader questions are posed, such as the impact of the system on new business practices, on the economic structure, or on the position of the company in an international context.

It can be claimed, then, that Organizational Theory offers a very rich source of information, in looking on the individual as an actor in a specific organizational structure, and as having a status or form of behaviour which can be modified by

the introduction of a new system. Relations at work and the influence of various levels of management are also matters of concern in this field.

The effects of the incorporation of innovations into the organizations are receiving an increasing interest on the part of researchers, due to the rapid, pervasive expansion of computers and networks. A remarkable taxonomy of organizational changes in the field of education has been provided by Conley (1993). This author distinguishes three types of changes (in Cassidy and Lane, 1994):

- **renewal activities**, helping the organization to increase the effectiveness in their current tasks,
- **reform-driven activities**, which alter existing procedures and rules in order to permit the adaptation to the new ways of working tasks, and, finally,
- **restructuring activities**, changing fundamental assumptions, practices and relationships both within the organization and between this and the external conditions.

Coming to the particular subject of implementation, Wilson (1991) shows a set of barriers to the implementation of IT strategies, from a large survey of corporate organizations in the UK. The 'top five barriers' found were:

- The difficulty in recruiting staff to support implementation
- The nature of business itself, not allowing for long-term planning
- The difficulty in measuring benefits derived from IT
- The lack of resources for user education in IT
- The already existing technological infrastructure

The image of using technology as a way of gaining competitive advantage is now creating a lot of interest in the definition of IT strategies in corporate organizations (Wilson, 1991). Even in Universities, it is becoming widely recognized that students having access to technology are more marketable, thus increasing the prestige of the institution (Lloyd, 1991; Boettcher, 1993). It is hoped that this belief will create favourable conditions for the testing of these factors and lead to valid results concerning their relative importance in setting up TST systems.

2.5. Research Projects in the DELTA Programme of the EU

The EU has designated the problem of Training as a priority area. The growing need for professionals to constantly update their knowledge and skills has given rise to several European initiatives in this sense, starting from different application areas.

The DELTA Programme was born as an initiative of the Second Framework Programme of the EU. One of the main aims of the initial stage, called Exploratory Action, was to investigate ways in which technology could facilitate, in a cost-effective way, the implementation of large-scale Flexible and Distance Learning Systems in Europe.

Two projects from this programme have been selected for discussion in this chapter, as they have contributed to the construction of the Theoretical Framework for the work carried out in this thesis:

- The BEACON project , though included in the same Action Lines, has focused rather on the implementation plans and strategies for Technology-Based Training (TBT) applications.
- The CTA (Common Training Architecture) project was intended to define and implement a technological framework for distributing training and allowing easy access to any scenario, based on the notion of interoperability. The concept of Architecture, central to the project, has for its part inspired the architectural modelling that is one of the key aspects of the ADAM approach.

The basic concepts underlying each of these projects are described in the following sections.

- **The BEACON project: The Implementation Framework**

The objective of the BEACON project is to provide practitioners with guidelines for the implementation of learning technology in the organization. An important point underlying the philosophy of BEACON is the belief that non-technological factors (motivation, commitment to innovation, learning principles, etc.) play a much more important role in the implementation process than the purely technical ones.

Learning technology is conceived as an innovation defined as "*...the commercial exploitation or application of an idea or ideas*" (BEACON Consortium, 1994, pg. 12). This view of innovation differs from the one adopted by Innovation Theories (previously analyzed in this study), in that it places the emphasis on the extensive implantation of the new idea rather than on individual initiative in adopting it. This approach further develops the market aspects which are central to the

project; this theme will not be covered in the present review, since such perspectives lie beyond the scope of the methodology to be discussed here.

The concept of **implementation** refers to the integration of the technologies into training systems and the exploitation of the resulting services. The commercial approach again underlies this definition. The project is seen from the viewpoint of the developer and/or supplier of learning technology offering their services to user organizations, while the approach taken by this thesis is that of the user organization itself trying to manage the introduction of a TST system, even if outsourcing can be practiced at a certain level.

Implementation is thus conceived as a service, close to the reality of the user and the target organization. This conception is graphically shown in Figure 2.6. The explicit requirement of having the users present in the process in order to customize the service to training and organizational needs as much as possible means that one of the essential stages taken in the Implementation Strategy is the detailed **Analysis of the Context**. Another central concept of the project to be incorporated into the strategy is the need to cope with change in organizations.

The project provides a good background to the analysis of comprehension of the business concept, and how the 'emerging intelligent learning organizations' face the problem of innovations in general, and of learning innovation in particular. As far as the implementation process is concerned, the project gives some useful hints about the analysis of the target organization, the design of a strategy, its further implementation and, finally, the evaluation and management of the process.

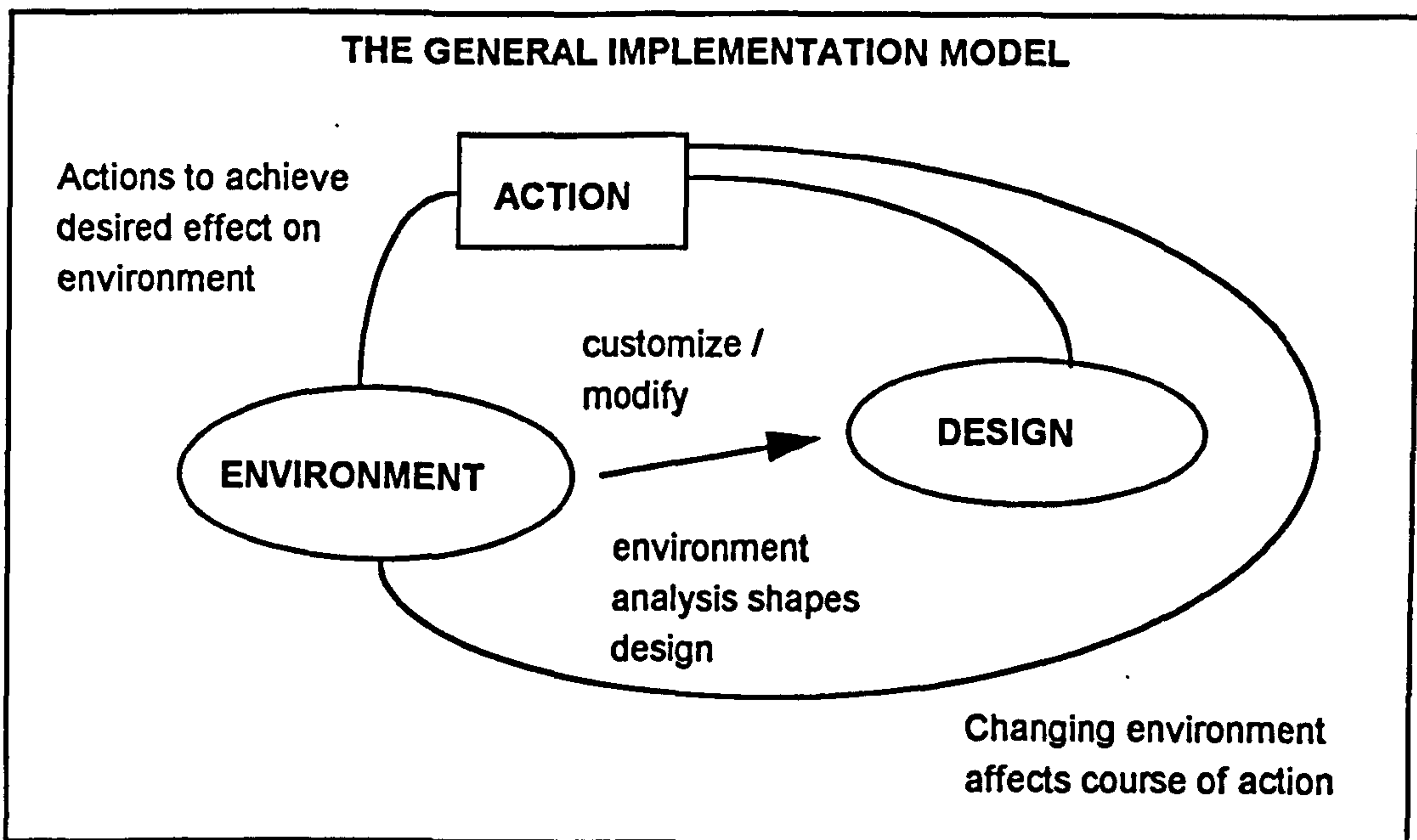


Figure 2.6. The BEACON Implementation Concept (BEACON, 1994)

- **Common Training Architecture (CTA): In Search of the Standard**

The CTA project emerges from the need to harmonize the technology-based learning infrastructure and to formulate prescriptions about the extension of this sort of service to Europe. One of the most important hindrances to progress in this field has been identified as the lack of technological standards which means that users face a wide diversity of options for which no interoperability is guaranteed. The project tries to reach consensus among all the partners involved in DELTA, by providing guidelines and fostering debate leading to the creation of a common viewpoint from which infrastructure standards can emerge.

CTA work is based on the concept of Architecture as "a framework of functional components embracing a set of standards, conventions, rules and processes in which there is human involvement" (CTA Consortium, 1993). There is recognition of the limited attention that human factors have received in the design and implementation of Information Systems in organizations. CTA tries to overcome

this problem by starting the design process from precisely this type of data, which are called the ELT (Education, Learning and Technology) Aspects:

- *learner environment and age range* - general characteristics of learners
- *learning environment* - covers: home, educational institution, educational/training centre, and work.
- *ELT task* - description of task requirements and conditions
- *learning support actors and roles* - they can be analyzed in the light of different models or frameworks (e.g., the CCITT AVIS recommendation is illustrated)
- *learning-work transfer* - this factor studies the suitability of the ELT task and the work situation, as this can have important implications for the technological solution chosen
- *learning material flexibility* - degree of adaptability or re-usability of materials produced
- *communication services* - classification of these services can be made in view of psychological theories or more technological factors
- *presentation systems* - infrastructure available to the learner, emphasizing associated costs in every case.

The analysis of the organization, and especially of the 'stakeholders' in the system, should be made in the light of these factors, and will constitute the initial input in the process of system design.

The CTA project can be contemplated:

- As a framework for the implementation of technological solutions matching business and educational needs. Such a framework integrates a set of well-known, extensively used standard models in the Engineering and Business

fields, like the Open Distributed Processing (ODP) modelling approach, or the ECMA Service Classification for the design of a taxonomy of technology services. For their part, Object Oriented models are used to acquire comprehensive construction of the models. These models operate in the so-called ELT (Education, Learning and Training) Aspects, which result from an analysis of the organization and the activities performed within its context.

- As a process, in which it constitutes a methodological framework offered to the enterprise for the analysis, design and implementation of technological solutions optimally meeting business requirements. The emphasis on the standardization of the project offers a guarantee of interoperability for the solutions implemented along these guidelines.

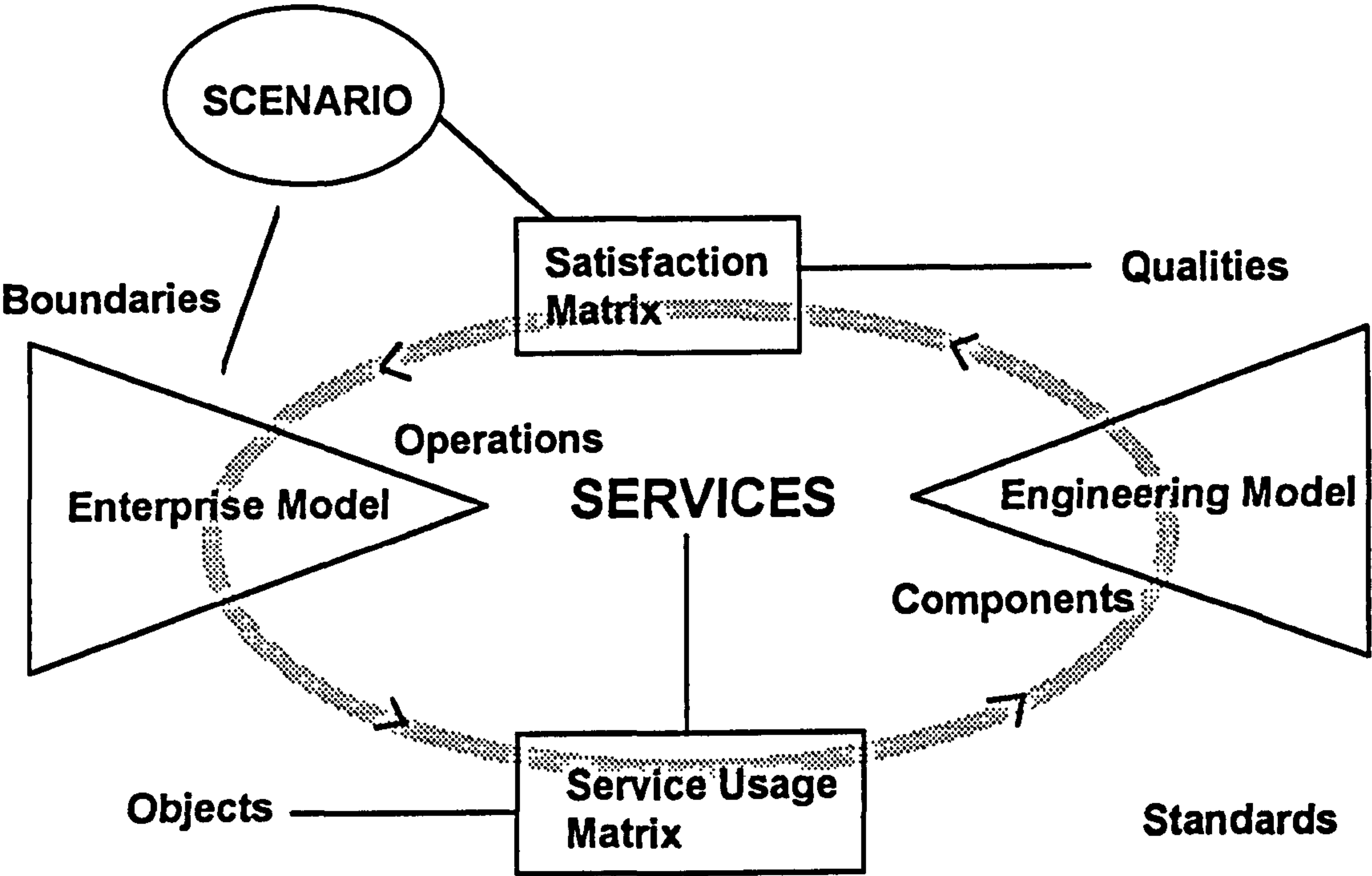


Figure 2.7. The CTA Framework and Process (CTA, 1994)

Given the main objective of the project, that is, to provide a means for harmonizing technologies and infrastructures in learning services, it is necessarily of a highly technical nature, and for this reason will not be analyzed in further detail here. The CTA Framework and process is shown in Figure 2.7.

2.6. Conclusions

The contributions made by research in the areas addressed by this review are summarized in Figure 2.8. The following are conclusions relevant to every area:

2.6.1. IS Methodologies

The MIS milieu has contributed to the study of TST systems methodologies in general, constituting a real forerunner. The application area in this case, in contrast to the type of systems which constitute the core of the thesis, is obviously quite different. However, the consequent 'lessons learned' from MIS research represent interesting inputs to the present work.

- Methodologies are considered highly useful in:
 - providing guidelines for good practice,
 - showing the way in stepwise form to the novice specialist, and providing a guarantee of quality in cases where no system analyst is available, and in
 - setting control procedures, milestones and timing dimensions that are of great assistance for the management of the different partners involved in the project.
- Methodologies addressing social systems (as in the case of TST) have to take into account the purposeful and complex character of human activity.

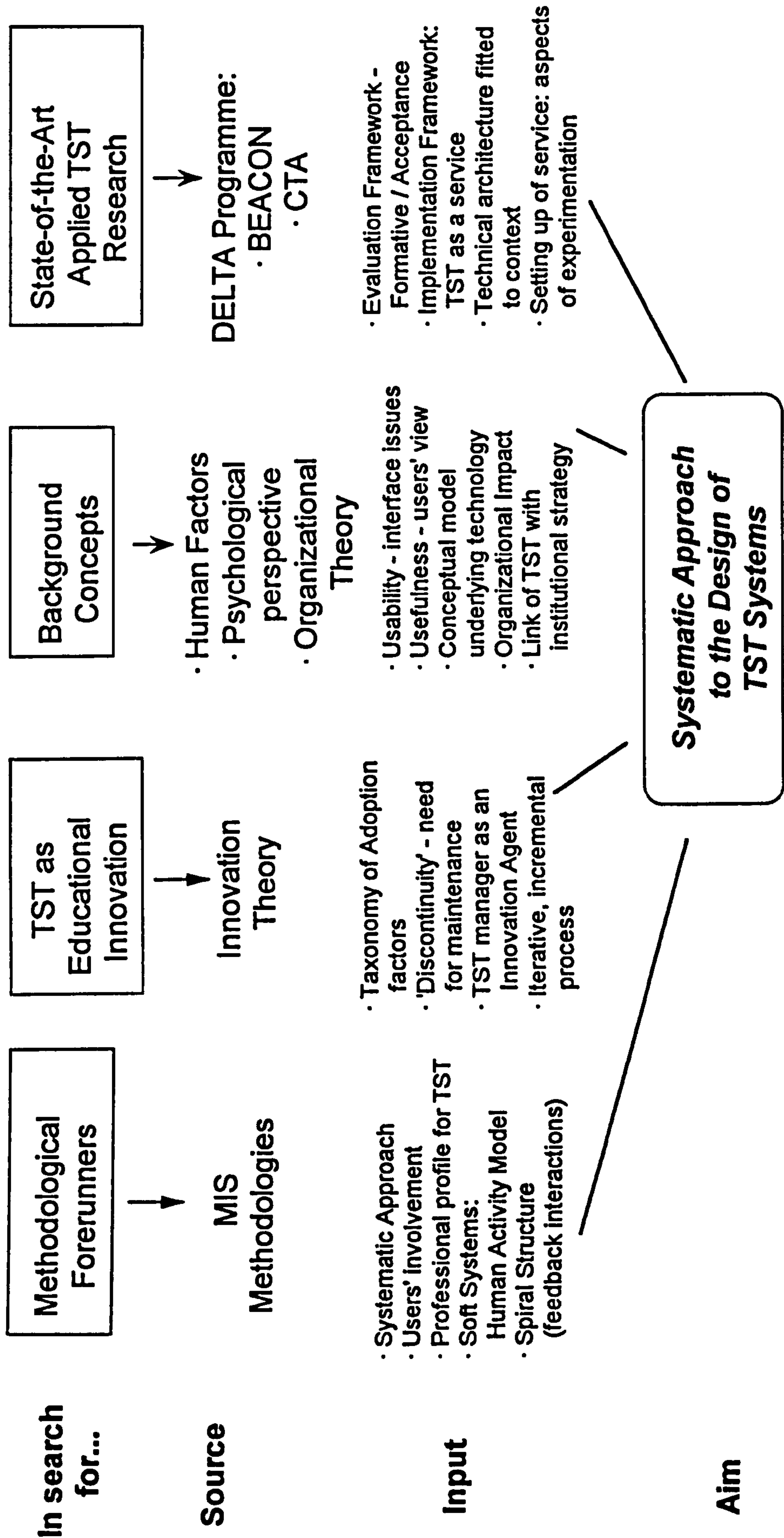


Figure 2.8. Contributions made by Research Literature: Summary

Therefore, they should be especially careful in considering contextual factors underlying the target system. They should also be conceived as sets of flexible guidelines for action, rather than as rigid prescriptions, in contrast to technical software development methods.

- The involvement of future users of the system is an essential factor in the methodological process, not only to validate the final stages of the design, but from the very early stages of analysis. Their input will modulate the design of the technical architecture, and at the same time acts as an adoption factor, in motivating people and by introducing the system into their activities. In this sense, meetings and workshops involving the different groups of stakeholders (previously described in the context analysis) have a great influence on the process of matching the system to the reality of its future implementation.
- A hybrid professional profile is required for a proper implementation of the methodology. This manager should be able to combine knowledge of the organizational structure and strategy with a command of the Telecommunications field. Given the difficulty in obtaining this kind of professional expertise, an interdisciplinary team is also recommended for the project.
- The process defined by the methodology should incorporate a spiral structure in the interaction between design (which is in the designer's mind) and implementation (the contrast with reality). A single feedback loop in the final stages of the process is inadequate; instead, a set of iterations between both stages is recommended, through a pilot experimentation stage in the case of TST.

2.6.2. Innovation Theory

The most relevant inputs of Innovation Theory for the purposes of the present work are:

- The approach taken to the adoption process as an individual initiative on the part of the users which has to be fostered and promoted by a set of strategies defined at the design stage of the system.
- The taxonomy of adoption factors at different levels, requiring particular actions and oriented to different target groups of the actors involved.
- The consideration of the possibility of 'discontinuation' of the adoption process. This point is important in that it affects the maintenance of the system, which should also include human oriented strategies as well as technical activities.
- The emphasis in the design of adoption strategies on incorporating a previous analysis of benefits and opportunities provided by the innovation, advantages which are to be stressed and which will become apparent to users. Again, this aspect reinforces the need to make a careful context analysis at the initial stage of the design process.
- The conception of the TST systems designer professional as an Innovation Change Agent, with a responsibility not only to produce the system but also to make users adopt it. The Change Agent should be supported by key members

of the organization, who also have to be identified in the previous analyses of the context.

- Finally, the view of adoption as an incremental rather than sequential process and the need for different tests and iterations before reaching the level of large scale system implementation and consolidation

2.6.3. Contributing Disciplines

The conclusions that can be drawn from Human Factors Research concerning of TST systems are the following:

- Firstly, these theories place the emphasis on those aspects of human abilities which are relevant to the design and development of hardware and software, and therefore strongly focus on interface issues. The need for this kind of study is obvious, since good interfaces are crucial to users' initial and subsequent interaction with the system. But, as is the case with most implementations of TST systems, the technology installed has already been developed, and the only choice is to search for the type that, within cost limitations, meets as many of the characteristics stated above as possible.
- Several of the considerations regarding usability from the Human Factors point of view refer to developments which are task-oriented, such as application packages (e.g. a word processor, a database or a CAL package). Telecommunications developments, by contrast, are claimed to be oriented either towards increasing (content-free) communication or facilitating the delivery of materials (whose applicability is not dependent on its content either). This is a differential characteristic of Telecommunications, which

means that some of these considerations are not valid in our case; however, criteria regarding interface design should be applicable to this type of technology as well, in helping users to communicate and collaborate with each other through the technological support (Alexander, 1992).

- When other aspects such as training and support materials are considered, they concentrate on how to use the technology in terms of commands and menus, rather than on what to use it for, addressing in this case issues like the conceptual model underlying technology. This aspect has been particularly explored by psychological approaches to the field, as we will now see.

For its part, the psychological perspective offers the following inputs:

- The main point addresses the Adoption Strategies, and is linked with the primary importance of perceived usefulness over ease of use of the tool. Therefore, it is necessary to increase of potential users' awareness of the usefulness of the technology, and to design some sort of induction about the conceptual model underlying it, before making them learn the 'how' of the tool, in terms of commands and navigation.
- The careful and continuous consideration of the individual's outlook concerning use of the technology, obtaining a cognitive view of the process, connected with other relevant variables, mainly attitudinal.

Finally, the main contributions of the organizational perspective to the design of TST systems are stated as:

- recognition of the need to take into account institutional and social aspects of the implementation process,
- the careful analysis of the organizational objectives that underlie any sort of innovation introduced into the organization,
- the consideration of the impact that the technology could have on the institution and the prospect of changes in roles and activities that this might bring about, and
- establishing the view of the user as a member of a social group, thus complementing the individual behaviour angle seen from psychological perspectives.

2.6.4. Projects under the DELTA Programme

These projects are obviously the ones which offer a much closer approach to this thesis. However, both the market-oriented, commercial approach of BEACON , on the one hand, and the engineering, standard-oriented, highly technical viewpoint of CTA, on the other, mark strong differences from the methodological framework that will be proposed in the next chapter.

Some of the strong inputs of the BEACON project for the purposes of this work are:

- Strategies are proposed for analyzing the implementation environment (e.g., performing case studies of successes and failures in training, comparing the results in each case).
- Design strategies that can cope with the rapid changes occurring in such a complex set of variables (mainly changes in technology and in the business itself).

- Consideration of learning technology as an innovation, and the extension of guidelines from research in this field, to other application areas.
- Emphasis on the search for key actors and the establishment of partnerships at different levels to guarantee success.
- Emphasis on the evaluation of the impact of the implementation at the different levels of the previous analysis, as well as on the importance of managing the maintenance of the implementation by means of pilots and users' validation.

As far as the philosophy underlying the CTA project is concerned it is of great value to this work in that:

- It revolves around the concept of architecture as a functional arrangement of technological components that are matched with human organizational activities; this concept constitutes a point which is essential to the TST methodology that will be presented in this work.
- It lays the foundation for the process of transforming training-related activities into technical parameters, finally leading to the selection of communication services.
- It recognizes the vital importance of keeping human and organizational factors at the centre of any technological development in TST system implementation.
- It is comprehensive and exhaustive in analyzing the context in which the system will operate.

- It is systematic but at the same time open to the introduction of different models and techniques that may best suit any particular organization.

In the light of the contributions from the literature studied here, and with a view to answering the research questions posed in Chapter 1, it can be argued that the development of a systematic approach to the analysis, design and implementation of Telecommunications-Supported Training Systems will contribute in a unique way to research in this field by:

- Providing a systematic means of coping with the challenge of comprehensively designing TST systems, covering both technical design and human adoption factors as well as educational innovation and implementation aspects, as they are understood by current state-of-the art research.
- Bringing a common understanding to the fields of technology and human activity.
- Providing an insight into the special features of TST systems and how they operate in the real world, through carefully studying them from a comprehensive and systematic perspective.

The following sections focus on the description and testing out of the ADAM approach.

Chapter 3

The ADAM Approach

3.1. Introduction

3.2. The Philosophy of ADAM

3.2.1. The Concept of Architecture

3.2.2. The Concept of Adoption

3.3. ADAM Design Requirements

3.4. Modelling Orientation

3.4.1. Training Settings

3.4.2. Telecommunication Scenarios

3.5. Coverage: The Application Scope of ADAM

3.5.1. A Methodological Framework

3.5.2. Potential User Organizations

3.5.3. Profile of the ADAM Practitioner

3.5.4. Uses of ADAM

3.5.5. Aspects Beyond the Scope of ADAM

3.6. Description of the ADAM Approach

3.7. The Testing Out of ADAM: Evaluation Criteria

3.1. Introduction

The present chapter will describe a systematic approach to the analysis, design and implementation of Telecommunications-Supported Training (TST) systems, the ADAM (Architecture Design and Adoption Model) approach. The development of the approach and its validation in two real-life situations constitute the core of this thesis.

The previous chapters showed that it is possible to deal with the problem of designing TST using Systems Engineering Methodology (Hall, 1989; Layzell and Loucopoulos, 1989), and in fact this has been the basis for the development of ADAM, as we will now see. The use of such techniques as a valid framework for this sort of system has been shown by the growing use of Instructional System Development (ISD) methods. Equally, the field of Information Systems, in what can be regarded as a search for effective technological support to human activities, has also used Systems Engineering in its developments.

The field of Soft Systems Methodology, however, has modulated the ADAM approach in that a TST system is here considered as a Human Activity System (Checkland, 1990), and for this reason greater attention is paid to organizational and context analysis than would be usual from a purely 'hard' engineering perspective. The awareness of the degree of uncertainty with the TST system as regards the unpredictable state of some of its variables (that is, the behaviour of individuals and their influence on the context as well as the influence they receive from it) is also a contribution of Checkland's approach. However, the technology-driven character of relevant design decisions about TST systems has meant that the most reasonable approach to this work is a 'semi-soft' one, in which a 'hard' solution has to work in a 'soft' environment.

Following the guidelines of a traditional Systems Engineering (SE) perspective, the description of the approach is made in terms of the following aspects (Layzell and Loucopoulos, 1989):

Philosophy - every systemic and systematic approach requires a basic concept under which the boundaries of the target system can be defined. Such theoretical core defines the system components, their attributes and the types of relations they can maintain if the system is to operate properly (Matheron, 1990; López-Fuensalida, 1990).

Design requirements - these are the objectives to be achieved by applying the method. They are also called the 'system value' (Hall, 1989)

Modelling Orientation - techniques to be used in system description

Coverage - extent of the development cycle and method limitation

Deliverables - these are the 'tangible' outputs of the method, defined for every stage.

In the following sections, the ADAM approach and how it was developed will be described in these terms.

3.2. The Philosophy of ADAM

3.2.1. The model of TST: Concept of Architecture

The basic concept underlying the ADAM approach is that of Architecture (based on Zorkoczy, 1989) which in its most general aspect can be defined as follows:

The structured arrangement of components optimized to achieve high performance while avoiding unnecessary expenditure.

Bearing in mind this concept, a TST system is defined for our purposes as follows (after Simón and Zorkoczy, 1991):

A Telecommunications Supported Training System is conceived as a functional structure of technological components (Telecommunication services running over Telecommunication networks) implemented in a training environment in order to optimize the performance of its actors.

This definition views the TST system as a set of technological components acting as a 'layer' under the training activities, and whose functionalities support every actor involved. In this way, technology is at the service of human activities, its components being selected and deployed only when their usefulness is demonstrated.

The components of the TST system, as a result of the above statements, would be:

The Organization within which the system will operate

The Users who carry out the activities requiring support

Tasks that have to be performed

Services, defined as the exploitation of telecommunications technology for educational purposes

The Technology (applications and networks) implemented and deployed

Everyone of these components has a set of attributes or characteristics that will affect the operation of the system as a whole. Likewise, various relations can be identified between the components. The model presented in Figure 3.1 shows the components and attributes of a TST architecture, and outlines the basic relations established among them. These can be summarized in the following way:

People (who have personal attributes) are influenced by the organization in which they act. Within this context, they are associated with a specific set of tasks (that make them play an organizational role). Their performance in such tasks can be improved with the support of services, that are provided by telecommunications technologies. In using such services, people experiment reactions that can lead to their acceptance of the technology, which would imply an improvement in their performance. This improvement, finally, will influence the original organizational goals and context.

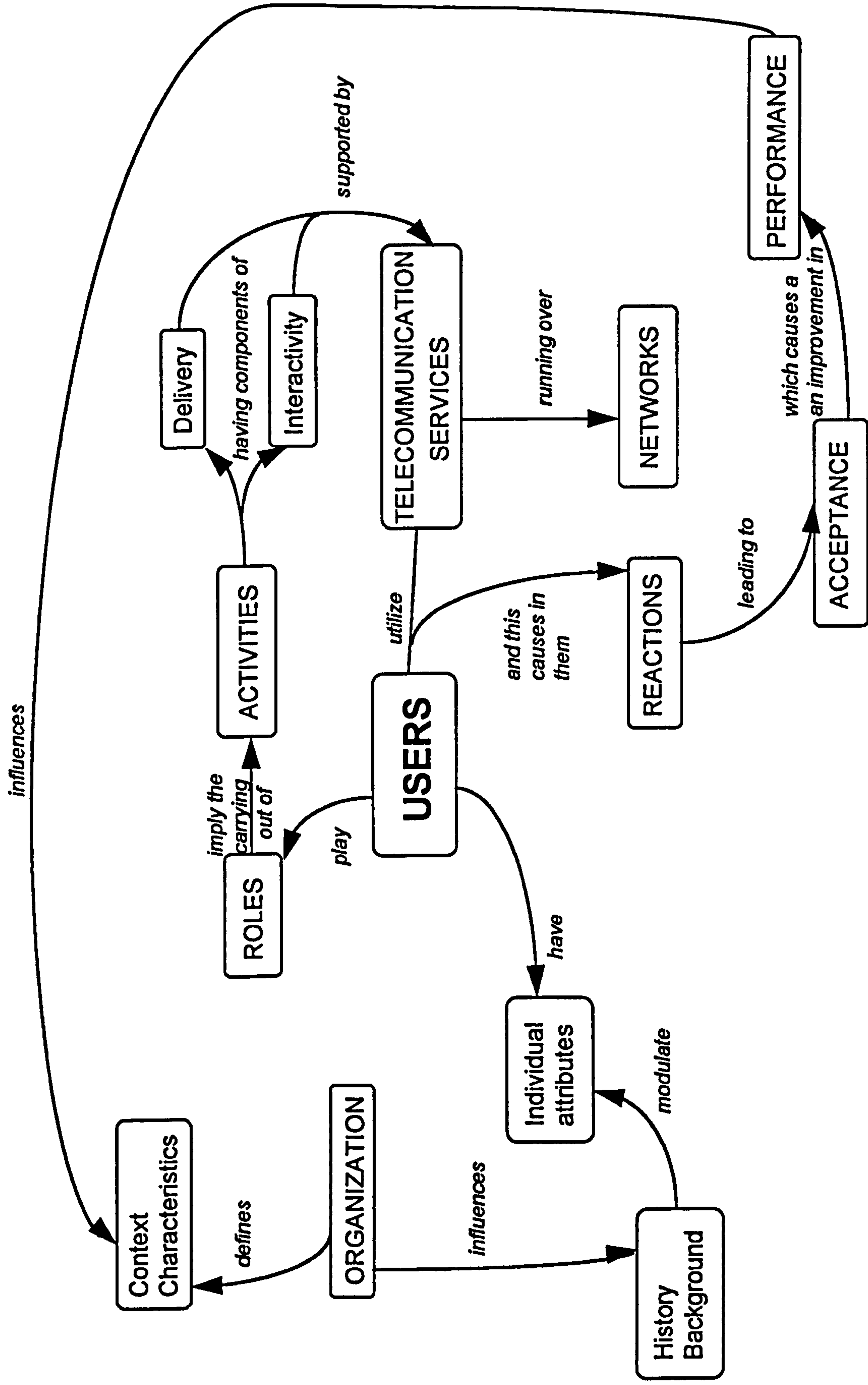


Figure 3.1. User-Centred TST Model

It is important to mention at this point that both the people and task components of the TST system, as it is conceived in this work, include every role contributing to the training process, and not just those regarding the teaching-learning situation. Administration (enrolments, bureaucracy), management (line, training and strategic) are examples of roles that can be of interest in a given system in virtue of their potential improvement. The reason for this is that Telecommunications technologies are introducing a 'globalization factor' in which roles become more and more interdependent (OTA, 1989; Sankar et al, 1993; Lane and Cassidy, 1994), and TST systems resulting from the application of ADAM have to be open enough to cope with this globality.

The organization may be regarded as the suprasystem in which the TST system acts. Its central influence in the process has already been shown when we discussed the role of the context in Human Activity Systems. The degree of uncertainty that it conveys determines the way in which the analysis phase of ADAM is conceived.

3.2.2. The Concept of Adoption

The concept of Adoption is the other main pillar upon which the ADAM approach has been developed, as its very name (Architectural Design and Adoption Model) indicates. Its importance derives from the conception of the TST as a Human Activity System, in which people have to make decisions on how to behave as far as the use of technological support is concerned.

The term Adoption has already been defined in the framework of Rogers' Innovation Theory as "... a decision to make use of an innovation as the best course of action available". Within the specific field of Computer-Mediated

Communication (CMC), the work of Hiltz (Kerr and Hiltz, 1982; Hiltz, 1988) has illustrated a very similar concept, that of Acceptance, defined as: "... the degree of willingness of an individual or group to utilize computer-mediated communication systems." (Kerr and Hiltz, 1982, pp.57). The authors recognize the degree of subjectivity involved in the concept, as well as the difficulty in measuring it (ibid.). They also state that acceptance can be equated with 'usage' if four conditions are fulfilled:

- (a) The users have a task that can be performed with CMC.
- (b) Access to materials is provided.
- (c) Users are free to select alternative systems.
- (d) Users are well-acquainted with the system's functionalities and know how to use them.

Kerr and Hiltz provide a comprehensive list of characteristics that may affect acceptance and usage, classified into four groups: the individual user, the group, the tasks and the system itself. As far as ADAM is concerned, it can be stated that:

Condition (a) is guaranteed with the Human Activity modelling process, by which the technological support is obtained directly from the tasks that the users perform regularly.

The condition of access (b) is defined at a later stage of the approach, in which the architecture is translated into a physical topology of access possibilities for users.

Condition (c) rather depends on the context (e.g., it is widely known that in most organizations the key element in introducing word processors in clerical departments is the prior removal of typewriters, thus eliminating alternatives

for users), but has clear implications for the selection of pilot users to test the TST design if conclusive results are to come out.

Finally, condition (d) is likely to be the most important one, in pointing to the design of information and training strategies at different levels of audience, content, etc., in order to maximize the level of acceptance of the system as it is implemented.

The concepts of Adoption and Acceptance constitute the basis of how ADAM deals with relations between the technology and the users. This basis has taken the form of two actions:

ADAM includes, as part of the architectural design, the elaboration of a set of Adoption Strategies matched to the technological components. Such strategies are structured into levels that correspond to the ones established by Rogers (op.cit.).

Another essential activity of the approach is the elaboration of an Evaluation Framework for the results coming out of the pilot experiences. It aims at exploring the degree of users acceptance of the architecture implemented, and the aspects that can be improved in this sense. For this purpose, evaluation variables are based on the classification proposed by Kerr and Hiltz (op.cit.)

3.2.3. Education and Training: Implications for ADAM

The differences between Education and Training, both being learning processes, have long been reported in the literature. Buckley and Caple (1990) select the following definitions from the 'Glossary of Training Terms' of the Department of Employment:

- **Training:** A planned and systematic effort to modify or develop knowledge/skill/attitude through learning experience, to achieve effective performance in an activity or range of activities. Its purpose, in the work situation, is to enable an individual to acquire abilities in order that he or she can perform adequately a given task or job.
- **Education:** A process and a series of activities which aim at enabling an individual to assimilate and develop knowledge, skills values and understanding that are not simply related to a narrow field of activity but to allow a broad range of problems to be defined, analysed and solved.

Several differences have been stated between both concepts (e.g., Kenny and Reid, 1987, in Buckley and Caple, 1990 in terms of categories such as process, orientation, method, content and precision). But for the purposes of this work and the ADAM systematic approach we shall focus on the goal of the process, which in the case of training is to allow people to perform more adequately their assigned activities in the organization.

The assumption underlying the ADAM approach is that an organization plans to improve the performance of its personnel through investing in the implementation of a technological support. In this sense, institutions such as Universities, whose mission is to deliver education, may plan to introduce TST systems aiming at, for example, optimizing their face-to-face courses by running them in a “dual” mode, or increasing their prestige (and therefore their potential enrolment) using advanced teaching media. Reports such as Boettcher (1993) or the one produced by the Danish Ministry of Education (1993) introduce interesting discussions on how Universities contemplate TST as an strategical part of their business. Finally, the case study presented in Chapter 5 analyzes an specific design of TST to these purposes for the Universidad Politécnica de

Madrid, showing how a training system may be embedded in an educational institution whenever it wants to improve the performance of its faculty within a set of strategical goals.

3.3. ADAM Design requirements

Following Hall's principles on Systems Methodology (1989), as the systematic approach and the specific activities it recommends are the means by which certain goals are pursued, the development of the method has to start from the definition of such goals. They can be of a different nature: some may relate to the method itself, and others may attach greater importance to the research contributions that the application of the approach might make, while some necessarily consider the quality requirements of the systems that the method will produce.

The design requirements stated for ADAM were the following:

1. It should maintain awareness of the environment in which the system is to operate, thus providing overall solutions that work throughout the whole system's life cycle.
2. It should be able to identify and analyze the different architectural solutions for the TST system in its context, providing criteria for choosing the optimal alternative.
3. It should identify the needs, constraints and opportunities of the target system (whenever it is new or it already exists), and identify the impact it may have on individual users and on the organization, designing the corresponding strategies to make users adopt it.
4. Being, as TST are, a Human Activity System, in which people play a central role, ADAM should be user-oriented from its earliest stages.

5. The approach should act both as a design tool for new TST systems, and as an instrument to analyze systems already implemented.
6. Given the high degree of complexity and interdisciplinary work of TST systems, ADAM will provide both a structured procedure for teamwork and also control mechanisms during the process for management purposes, from a practical viewpoint.
7. From a research point of view, ADAM must be instrumental in explaining how TST operate in the real world. The approach should therefore provide (as much as possible) consistent systems, yielding comparable results and consequent conclusions, thus expanding knowledge in this field.

Figure 3.2. shows these requirements and how they relate with the different disciplines and issues discussed in the previous chapters.

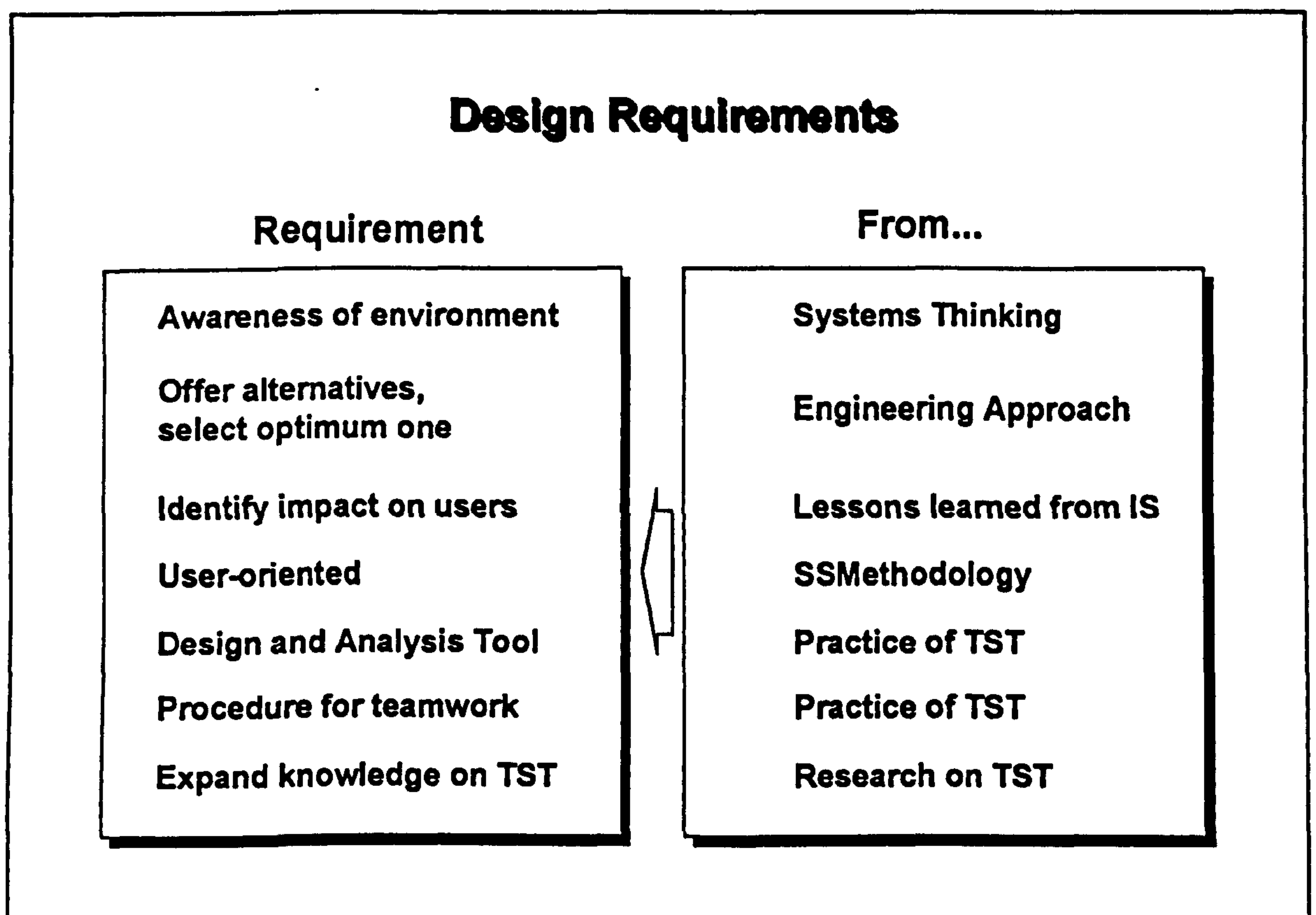


Figure 3.2. Design Requirements for ADAM

3.4. Modelling Orientation

Modelling orientation is one of the essential features of a systematic approach. It allows the system to be described in terms of its relevant dimensions for the purposes of the designer. Holling (1978) provides an appropriate definition of a model as "a caricature of reality... leaving out all but the essential" (in Miser and Quade, 1985, pp. 191). A proper modelling technique should produce models which can be transmitted and which should serve as a basis for discussion and prediction of the system behaviour (Layzell and Loucopoulos, 1989). In our case, the highly interdisciplinary character of the team involved in the design and implementation of a TST system makes this last point especially important: the model should be understood by the key members of the organization, and by the training-oriented and technology-oriented designers.

The technique adopted in ADAM falls under the so-called 'Judgmental Modelling' category, and is based on scenario-writing (Quade, 1985). Such methods are used in cases where the contributions of different individual points of view are regarded as essential in order to grasp a system's characteristics, and where the system is difficult to describe in quantitative terms. The objective here is not so much to come up with a formal model, but rather to offer a consistent and comprehensive organization of the information to help in decision-making at the design stage.

In our case, the modelling has been split into three types of analyses:

- 1. Training Settings**
- 2. Telecommunication Scenarios**
- 3. Requirements, Constraints and Opportunities (RCO).**

3.4.1. Training Settings

A training setting can be defined as a *systematic description of the environment and conditions in which a training-related event takes place*. This description is made in terms of the *actors* involved, the kind of *activities* performed, the resources required being *inputs* and the type of outcome *outputs*. The setting is very closely related to the organization under study.

The analysis of training settings is based on traditional job analysis methods (Buckley and Caple, 1990; Romiszowski, 1984). Through traditional techniques, mainly in-depth personal and group interviews and questionnaires, a list of the activities performed within the training system is compiled and the activities described. It is important to note that the analysis of the training settings can (and should) be discussed and checked directly with the key members of the organization; the TST designer and the client should still 'speak the same language'.

An important feature to mention at this point is the fact that the analysis of Training Settings is carried out without any prearranged definition of roles and activities. In our experience, there is a lack of uniform terminology throughout organizations. At an earlier stage of this work, some research was carried out into modelling techniques with a prearranged set of roles and activities (Simón and Zorkoczy, 1991). Both interviewing and questioning techniques were used in five large British and Spanish companies. Results showed that the structuring of training activities and the terminology used for roles and activities varied widely in every company; on the other hand, managers and technical staff found it very difficult to estimate items such as 'the proportion of time in the whole training process devoted to design', and 'roles involved in the needs analysis stage'. Even much simpler concepts, such as 'what is a tutor?', had very different meanings for different organizations. Understanding 'what a training system is' requires a much

more customized procedure of analysis if useful information is to be collected for the purposes of TST design. The resulting model defined is shown in Figure 3.3 (op.cit.).

3.4.2. Telecommunication Scenarios

We should not lose sight of the ultimate objective of ADAM, that is, the design of technological support to improve training performance. The power of Telecommunications lies in augmenting interaction possibilities among users, on the one hand, and facilitating the delivery of information, on the other. The objective of the second stage of the modelling process, the analysis of Telecommunication Scenarios, involves the conversion of the activities defined above into parameters that may eventually lead to decisions on the most efficient type of support in every case.

A telecommunication scenario can therefore be defined as an abstraction of a training situation showing the dimensions relevant to architectural-design purposes, thus allowing a matching of educational needs with technological functionalities. It is, then, an elaboration of the former setting, built around a series of properties that make it appropriate for analysis in terms of technological components. These factors are: information exchange needs, user grouping, synchronicity needs, communication forms, and the coverage and functionalities required. A more detailed explanation of each factor is included in a later section of this work.

Telecommunication scenarios are content-free, in contrast to the training settings. Their main value lies in the fact that they can be converted into technological parameters. As it has also evolved directly from the analysis of the setting, the telecommunication scenario constitutes a bridge linking both fields, and makes progressive modelling possible.

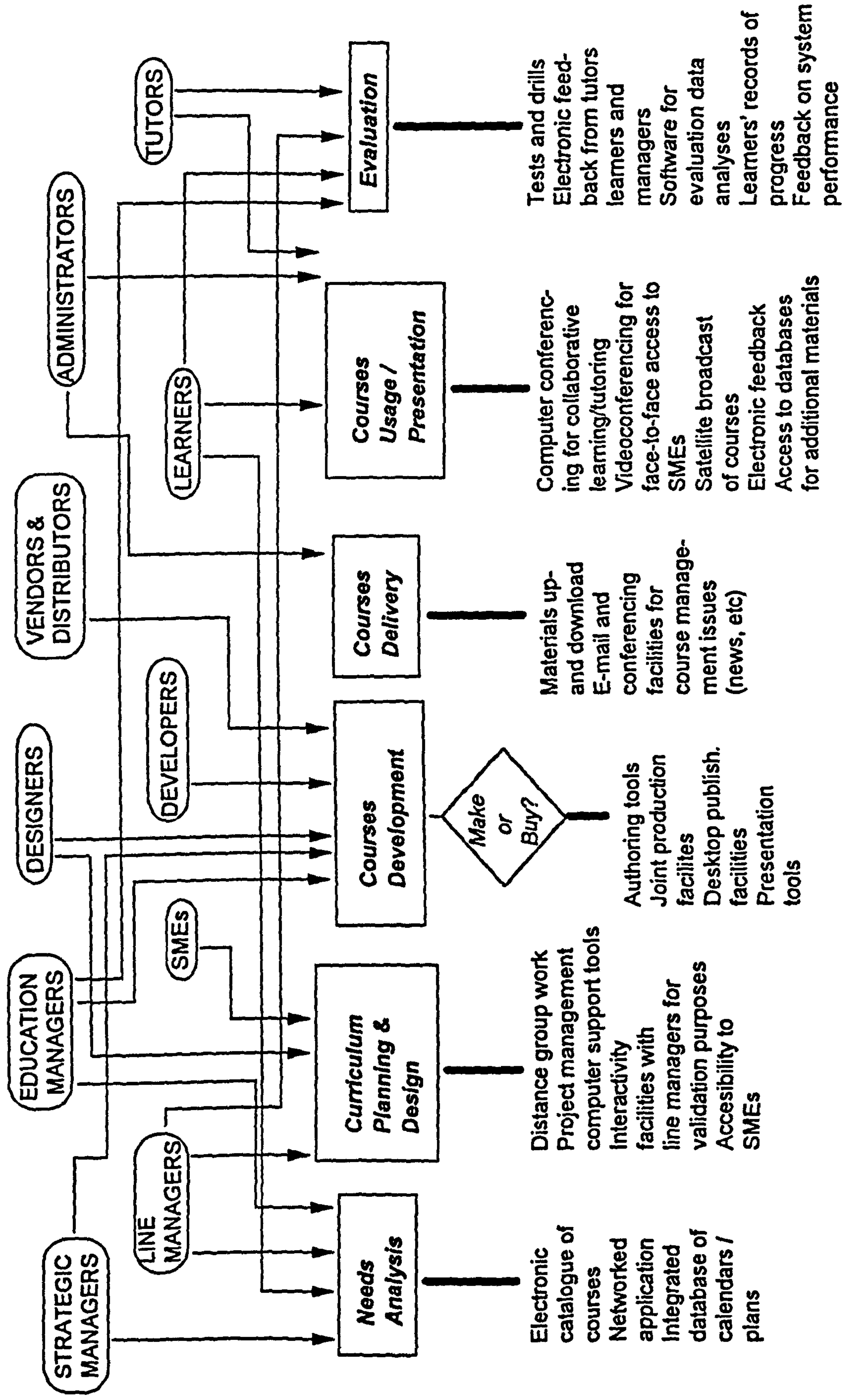


Figure 3.3

Theoretical model of a Technology-based Training System

The technique of scenario-writing has been shown to be of assistance in the discussion of several alternatives in a system design process (Zorkoczy, 94). Its use can vary according to the method. For example, the CTA project uses a set of pre-defined scenarios with a view to generating a specific view of a global architecture from the analysis of its individual components (CTA consortium, 1994); this conception of scenario permits the visualization of the 'future' system, and is also useful in testing intermediate stages of development (Zorkoczy, ibid). However, the view of the scenario here is instead an abstraction stemming directly from activity requirements, and providing the keys for proposals concerning alternative telecommunications services and networks. In this sense, the perspective is more along the lines of Helmer's thinking (cited in Quade, 1985), in that it is "clearly an art", for which few recommendations can be made:

"Scenario writing involves a constructive use of the imagination ... an operations-analytical scenario starts with the present state of the world and shows how, step by step, a future step might evolve in a plausible fashion out of the present one...exhibiting a reasonable chain of events that might lead to it."

(pp.202)

3.4.3. Analysis of Requirements, Constraints and Opportunities (RCO)

The third stage of the modelling technique is also a consequence of the view of TST as 'semi-soft' systems. It is also closely related to the design requirement of ADAM which states that it should 'evaluate the impact that the system can have on users'. In order to explore this condition, and using the same techniques as in the Training Settings analysis, users will be interviewed about their personal perceptions of the use of technological support in the context of their activities. Thus, we will identify a set of Requirements that the system must fulfil,

Constraints (negative forces) and Opportunities (new behaviours that the system may foster) modulating the resulting TST system model.

3.5. Coverage: The Application Scope of ADAM

In spite of the ambitious aim accomplished in this work, it is obvious that it would not be possible for the ADAM approach to cover all the areas of interest about TST systems. Equally, the earlier stages in which it is placed at the moment means that some of its properties as a systematic approach are not still developed, or are considered a matter of further research. Some of this current limitations are described in the next paragraphs.

3.5.1. A Methodological Framework

A TST system operates in a human, social context, where learning activities are the target. It would not be possible to state a fixed set of prescriptions that, if strictly followed, guaranteed final success. ADAM does not pretend to be a mandatory set of steps and rules. It contributes to the TST design project with a structured process, providing control mechanisms, but it is open so as not inhibit the creativity of the practitioner.

ADAM has been developed when TST implementations are at a primitive stage, and little is known about how to teach and learn through telecommunication media. It will necessarily have to evolve as applied research results give rise to conclusions and theories about the use of such systems and their adoption in the organization.

3.5.2. Target Organizations

This framework is applicable to any type of training system within the context of Adult Education: departments in private organizations, training centres, universities, etc. As it is currently conceived, the targets are systems which have already been implemented and which may incorporate technological support into some parts of their processes. But it might also consider the design of training systems from the point of view of an organization where no prior educational activity exists. This being the case, the modelling process of the training system would have to be preceded by a description of the training objectives and the activities stated by the user organization.

It is also appropriate to point out here that ADAM has emerged from current research into TST system implementation in the context of the European Union. On the other hand, it has been tried out in Spanish organizations. Consequently, its applicability to other environments is still to be tested.

3.5.3. Profile of the ADAM Practitioner

The setting up of TST systems is a process that involves the joint efforts of training and technology staff from the earliest stages. The methodology stated here tries to permanently bring educational and technological issues to a common sphere of understanding and decision-making.

The ADAM approach constitutes a tool for training professionals to get to grips with functional aspects of the technology, in order to be in a position to participate in the design and implementation of the process, and validate and manage successive implementations. Conversely, it provides a tool for technology professionals to consider the context of their work in a comprehensive way, while becoming aware of individual, social and organizational factors that affect architectural decisions.

3.5.4. Uses of ADAM

The ADAM framework can be used both as an aid to design and to analysis. In the first case, it is used as a set of action guidelines, specifying tasks and deliverables at each of the stages, while in the second case it may be used rather as a checklist to supervise the actual implementation of the system. The usefulness of both applications will be demonstrated in the two case studies reported in this thesis, and the benefits of their adoption discussed separately.

3.5.5. Aspects beyond the scope of ADAM

There are aspects of the study of TST system creation that are not covered by ADAM. Most of them require further work in this field, while others can rely on well-established procedures already developed and therefore do not warrant particular design methods. They are:

- **Initial feasibility studies:** ADAM stems from the point at which a decision is made to design a TST system for the organization.
- **Analysis and design of training models underlying TST:** the framework focuses on the adoption of telecommunications media as a support to training activities that are currently being performed in a more traditional way. It does not explicitly question the effectiveness of such activities. Nevertheless, the modelling process is in itself a powerful evaluation tool, in making a detailed examination of the "how" and "why" of training and exploring possible improvements.

- **Technology development stages:** whenever technical developments have to be made, Software Engineering procedures should be incorporated into the framework where appropriate.
- **Specific aspects of project management:** ADAM being in the initial stages of development, the limited experience of application does not allow the estimation of project management aspects such as timing, budgeting, etc.
- **Tools:** As a framework, it does not deal with the design of tailored tools. However, references are made to standard techniques where appropriate.

3.6. Description of the ADAM approach

Figure 3.4 includes a graphical representation of ADAM as a model. For its part, Figure 3.5 shows the overall methodological process as is recommended by ADAM. As can be seen, the approach is structured into stages containing steps, which are subdivided into activities.

It should be noted at this point that every step and activity defined in the approach is inspired in one of the following sources:

Prescriptions coming out of research, either from ISD approaches, Systems Engineering, IS Systems or from many other contributing disciplines of the type of the ones discussed in Chapter 2. Their selection has also been made taking as a criteria the experience of the author in the design and implementation of TST systems in different contexts (Simón, 1992; Fries and Simón, 1993; Simón, 1994a, 1994b; Simón and Martín, 1994).

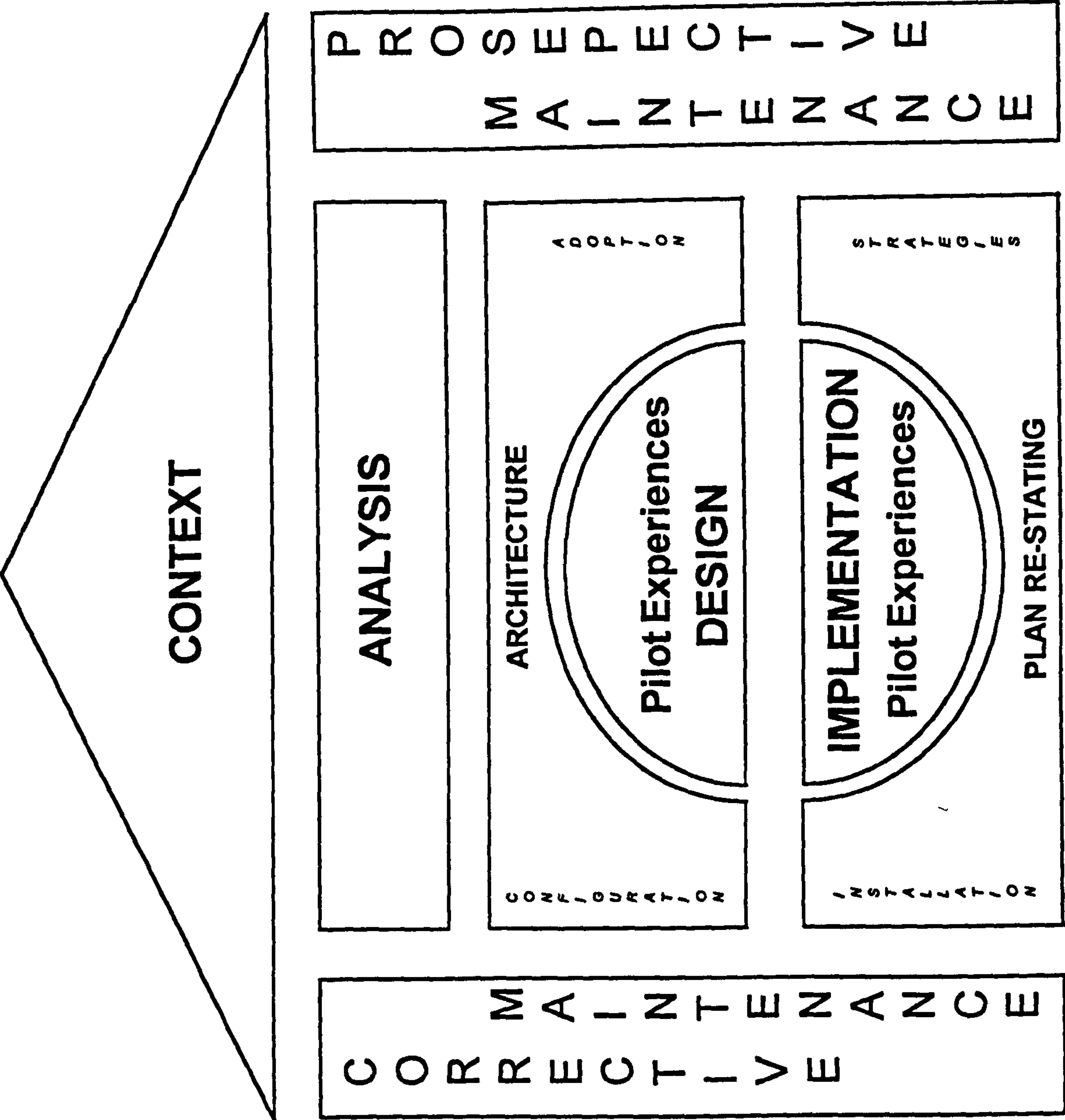


Figure 3.4. The ADAM Approach

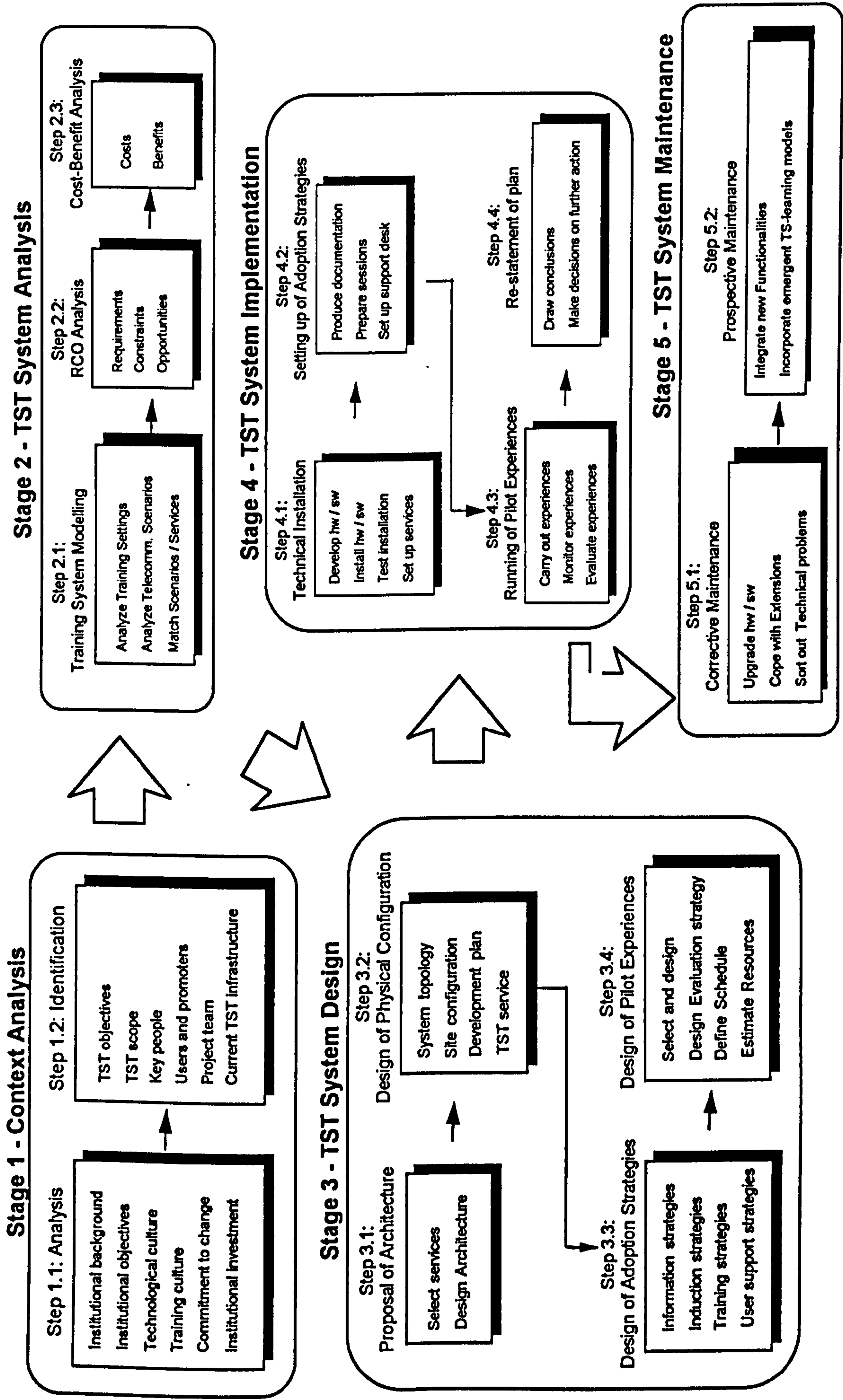
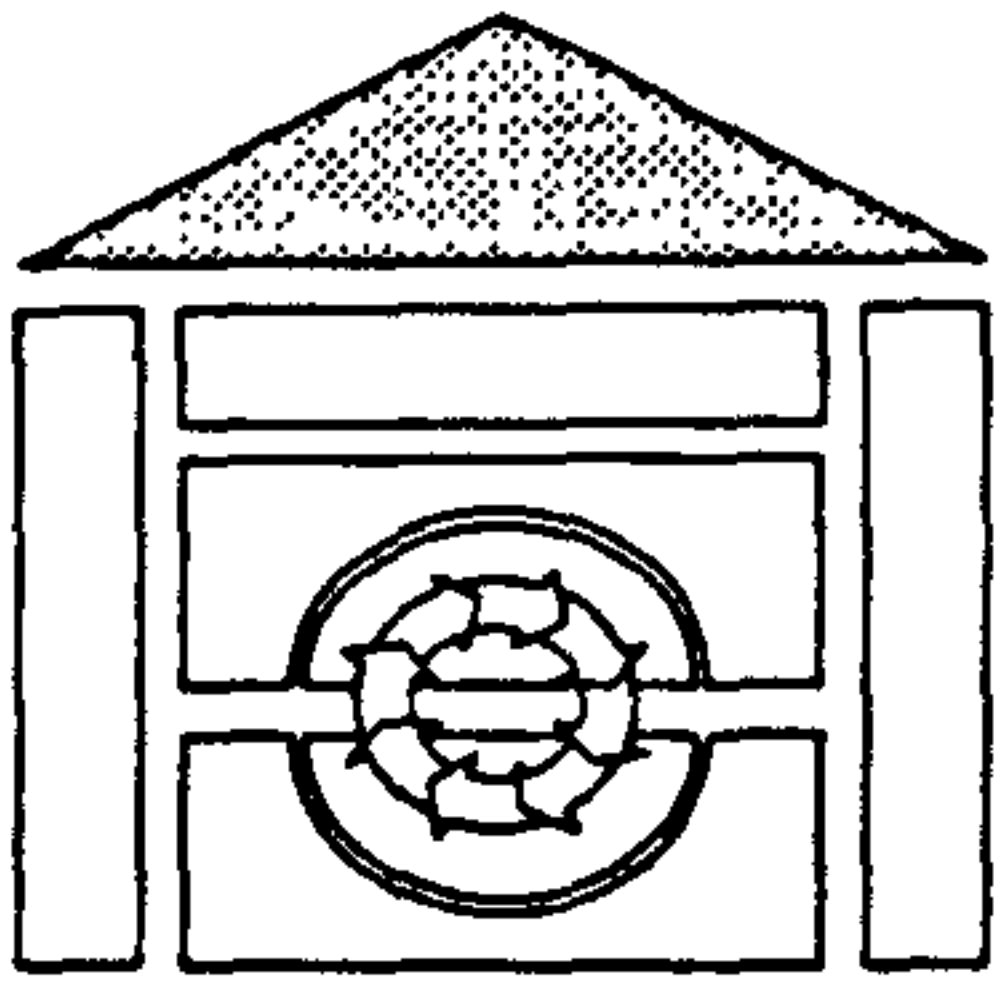


Figure 3.5. Overview of the process defined by the ADAM Approach

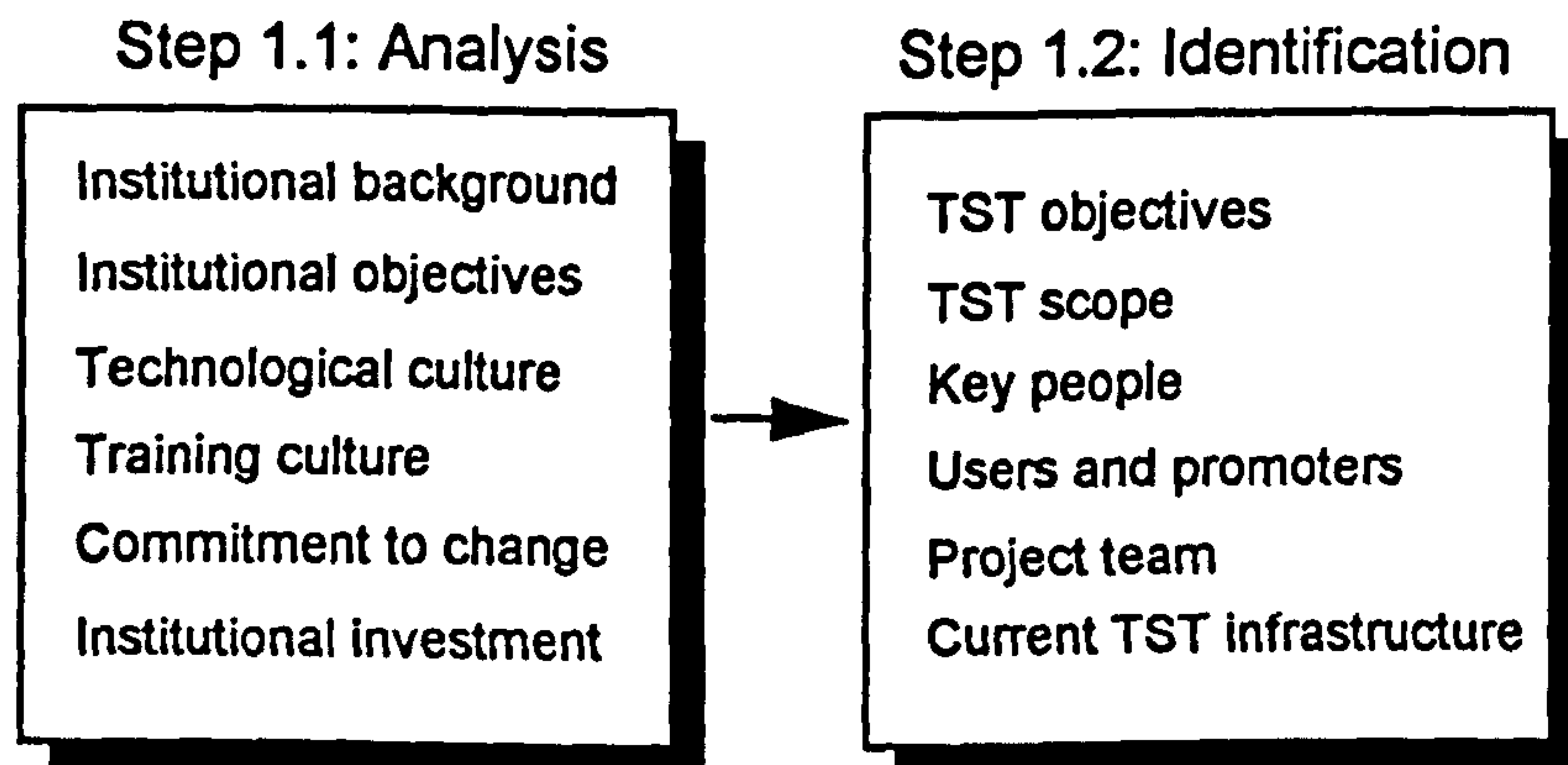
The following sections will describe these stages in more detail. Each of the stages is described in terms of the:

- Objective
- Description of steps and activities
- Techniques that may be used (where applicable)
- Deliverables
- Roles involved

The steps and activities are illustrated and discussed in greater detail within every of the case studies in Chapters 4 and 5.



3.6.1. Stage 1 - Context Analysis



Objective: To identify contextual conditions, both in terms of potential driving forces and barriers to the adoption of a TST system in the organization

The purpose of this stage is to analyze those conditions of the organizational environment that may be of relevance to the design and implementation of a TST system. It is especially important to identify the 'driving forces', that is, those aspects that may encourage the introduction of the system (e.g., motivated key people with an ample sphere of influence, areas or departments with urgent requirements that technologies can meet, etc.), as well as those with a possible negative effect on the diffusion of the TST (reluctance within line management, the negative attitudes of a group of potential users, etc.).

Checkland (1981, 1985) outlines the importance of the Analysis stage, and defines it as "...getting the richest possible picture of the context". He also recognizes the difficulty in coming up with a clear picture of the organization, since individuals

are often unclear about goals and processes, and their opinions frequently differ to the extent of creating confusion.

The stage is structured into two main steps. The first one covers the analysis of contextual factors. The results obtained are formalized and represent the input for the further step of the identification of key aspects, that will set the basis for the TST system modelling and design.

Step 1.1: Analysis

A1.1.1. Describe the institutional background

This activity consists of the study of relevant historical factors in the institution, the structure of the organization, which department or area has taken the initiative, its position in the organizational chart, and those background aspects that may be relevant to future design work.

A1.1.2. Describe institutional objectives

The objectives pursued by the organization in trying to introduce the TST system are analyzed here: image improvement, innovation, pedagogical effectiveness, solutions to specific problems, etc. Organizational goals may not be clearly defined, since social and economic factors become blurred; particularly in non-profit organizations, there can even be contradictory objectives (Anthony, 1993). Other studies also show that the criteria that may be stated by an organization for implementing innovative training technologies do not usually depend on cost factors, as one might think (Coopers and Lybrand, 1989), but rather on more strategic, logistic or organizational factors. The adoption of a proactive, future-oriented route into training versus a reactive problem-solving approach (Buckley and Caple, 1990), can also be useful in sizing the TST adoption plan.

A 1.1.3. Describe the technological culture

Examining the technological culture, that is, the extent to which technological tools are used either in training or in any other area, will give an idea of the degree of adoption already achieved in the organization. The analysis in this case will have to address two aspects:

existing infrastructure in the organization, with a view to incorporating technology if possible, and
users' opinions of technologies already deployed, perceived dangers and constraints, lessons learned from previous experiences, users' reactions and attitudes, etc.

A 1.1.4. Describe the training culture

The training culture within the organization also warrants study at this stage. It covers aspects such as the time devoted to staff training and the rewards/promotion systems (Buckley and Caple, 1990). Pedagogical strategies provided by training experts concerning interactivity, communication processes, etc. should also be studied here. It may be the case that potential trainees are highly reluctant to take up Distance Learning or Technology-mediated methods because they miss their subsistence allowances for travelling abroad. In other cases, even if employees are happy with on-the-job training, it is a strategy at different management levels to consider face-to-face meetings as necessary in order to foster a corporate spirit among the staff. Trade Unions and their attitude towards training should also be a matter of analysis because of the influence they may have on users of the system.

A 1.1.5. Estimate the commitment to change

This activity searches for the sort of route into TST systems that the organization intends to follow (Buckley and Caple, 1990): a pro-active, long-term strategic approach, or a re-active route, with the purpose of sorting out specific problems arising in the organization. Both routes will determine different types of institutional commitments to change, which will in turn affect the design of the TST system to a large extent.

A 1.1.6. Estimate the intended institutional investment

The investment that the institution intends to make in setting up the system also merits analysis. A division between short- and long-term budgets can be of help in that it sets limits for the resources to be allocated.

Step 1.2: Identification

A 1.2.1. Derive TST objectives from organizational aims

Activity 1.1.2 analyzed the aims pursued by the institution in initiating a TST design and implementation process. Such aims have to produce specific TST objectives that will serve as the basis for the modelling process.

A 1.2.2. Identify TST system scope

The intended scope of the system, both for the initial stages and for planned implementations in the future. Details of this aspect, namely, the required future size of the system, will map out the significance of the project, and will set a

starting point for discussion on how to shape the implementation of the designed system into different stages.

A 1.2.3. Identify the key people

The identification of and first contact with key members of the organization is a very relevant point that greatly influences the course of the project from the earliest stages. The management have to make final decisions regarding the budget, human resources and corporate strategy as far as the TST is concerned. The importance of having fluid communication with relevant managers in the organization is reported as one of the factors which is crucial to the success of the project (Collis et al., 1993). In the same way, the management of all the departments that will be involved in the design and development of the system have to be contacted, so that project team members are given particular responsibility for decisions in their areas.

A 1.2.4. Identify users and promoters

The definition of the users is another important aspect. A lot has been written about the importance of users' involvement from the early stages of the project as one of the best instruments of motivation (Briefs et al., 1983; Baddeley, 1991; Warburton, 1993). A sample of any group of potential users should take part in the project and has to be identified at this stage. In the case of pilot stages preceding final decisions regarding larger-scale implementations, the selection of users is of great significance. In this sense, the information collected may well give clues as to which would be a good group of users in terms of their capacity to transmit results to their sphere of influence, both formally and informally, and to the selection of non-reluctant users, or any other situation allowing for the control of as many variables as possible.

The presence of 'technological champions' (Rogers, 1983) who act as conveyors of enthusiasm and motivation to potential users is also desirable at this stage.

A 1.2.5. Identify the project team

An important outcome of this stage is the creation of a project team, including people from different areas of the institution. The creation of such a team and the fostering of fluid communication among its members is considered one of the factors which contributes most to the smooth running of the project. The team members should be given the responsibility for successive decisions made during the process.

The following areas in the organization must be explored in order to identify the members of the project team:

Corporate Development - If this role exists, the contact person in the early stages may belong to this kind of department, having to 'push' the project into the most suitable areas of the organization.

Training - Also required is a person in charge integrating TST as an element of the training programme or planning.

Computing or Technical department - this is the person who can select appropriate technology for the eventual users, since he/she knows which kind of technology is available and implementable in the organization. This role is ultimately responsible for the technical implementation and maintenance of the system.

Line management - it is important for users to perceive a positive attitude towards the system on the part of line managers (Buckley and Caple, 1990). This management support is carried out in time allocated for induction and training, reinforcement of the user of the system, and the creation of a favourable technology-supported working environment in general.

Users - a level of commitment from each individual user is also an important element. How to organize the participation of a sample of end users will depend on the design and scope of the first set of experiences to be carried out.

A 1.2.6. Identify current TST infrastructure

It may be the case that the organization already has installations that can be used by the TST system. In this instance, such infrastructure will have to be carefully studied in order to incorporate as much as possible of the current infrastructure. The design can thus derive the maximum benefit from previous costs incurred by the organization and at the same time build upon any adoption initiative already taken by users.

Stage 1 - Deliverables

- A very important outcome from this stage is the introduction of the TST designer in the organization. The conception of the TST designer as a Change Agent (Rogers, 1983) implies that he/she may achieve a certain degree of empathy with the environment (or 'homophily', in Rogers' terminology) at different behavioural levels (ibid.). On the other hand, the familiarization of the TST designer with the organization favours a user-need perspective that prevents innovation-driven attitudes which he/she may experience if working in excessive isolation.
- Another deliverable is to be a document containing the analysis of the factors previously stated, and also specifying the driving forces and estimated constraints, which can be discussed with key members of the organization. These data will further modulate the system modelling and design stages.

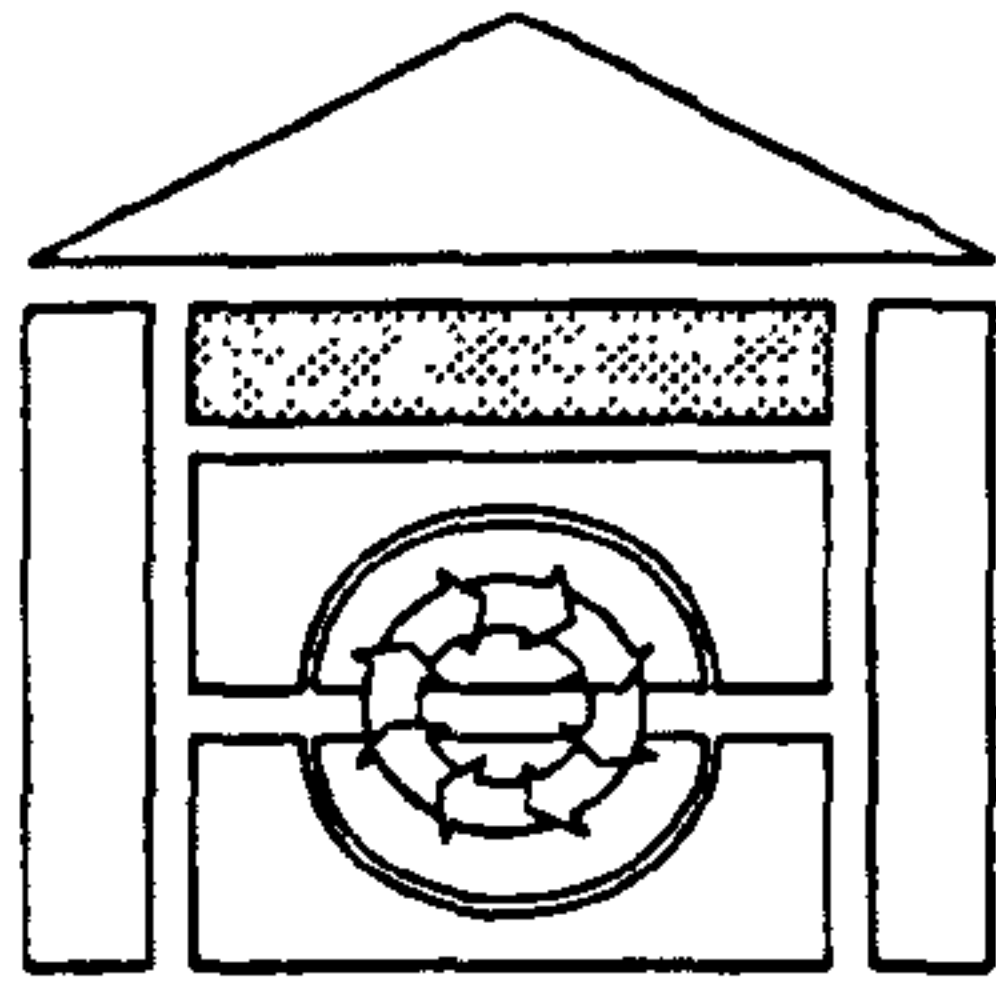
- Finally, the creation of a project team with responsible professionals from the areas involved, is considered by applied researchers in the area as one of the most important preconditions for obtaining positive results (Boettcher, 1993; Davies and Samways, 1993). The effectiveness of the team will have to be checked at every stage of the process, as we will see later in this methodological description.

Stage 1 - Roles involved

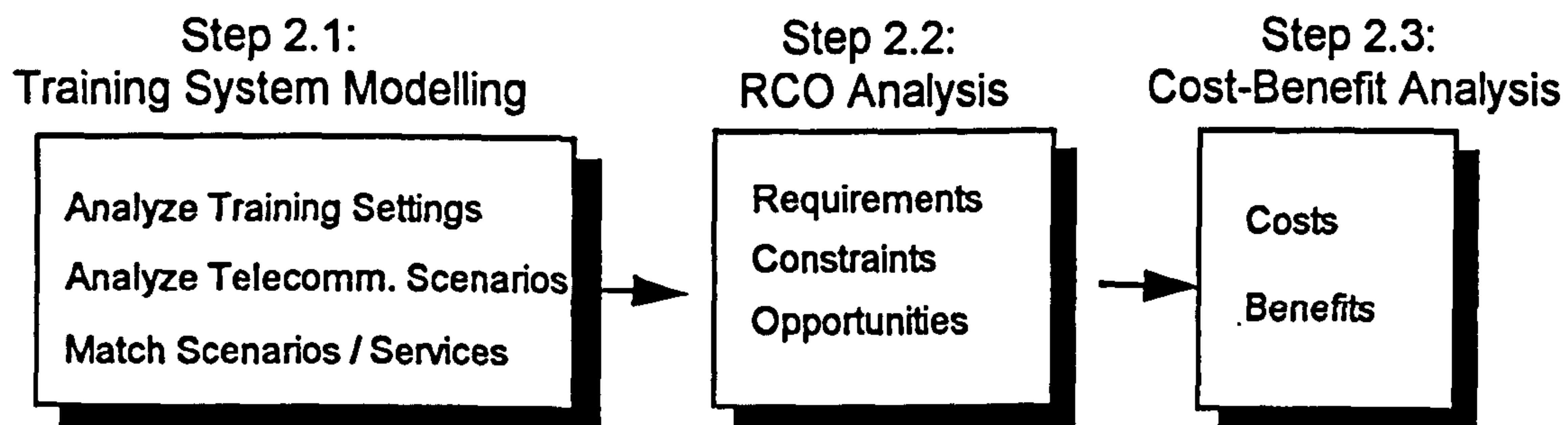
The TST designer takes a leading role at this stage. He/she will have to hold interviews with all the actors mentioned above, or with the corresponding ones detected in the organization. Key people and project team members are incorporated as actors immediately after they have been contacted and they have become familiar with the project.

Stage 1 - Techniques recommended

This initial stage is very similar to the one recommended by Instructional Systems Design (ISD) researchers. Personal interviews with key people are recommended as the most adequate technique. Unstructured observation can also give clues to attitudes, prejudices, etc., concerning the project (Hannum and Hansen, 1989).



3.6.2. Stage 2 - TST System Analysis



Objective: To elaborate a model of the current Training system into Telecommunications parameters, and to modulate it through the study of aspects that may affect the further selection or architectural solutions.

This large phase is composed of two different steps. It starts with the modelling of the Training system. The activity consists of analyzing the training settings to find out who is doing what, when and how in the Training system as it is currently working in the organization. Further elaboration takes place through a technical analysis in order to come up with telecommunication scenarios, corresponding to services and networks. An examination of the requirements, constraints and opportunities of the new TST system should also be made. Finally, a type of cost-benefit analysis has also to be carried out. All these factors will determine the design process.

We will now consider in some detail the different steps and activities involved at this stage:

Step 2.1. Training System Modelling

A 2.1.1. Analyze the Training Settings

Once the context has been defined, a detailed description of the whole training process as it currently works in the target organization has to be performed.

Procedures for performing this sort of task can be found in the field of training (Romiszowski, 1981; Buckley and Caple, 1990). Another example of how to make this kind of analysis can be found in the work of MacLagan (1990), who takes as the main axes the following elements:

Functions / Activities

Outputs

Roles involved

Quality indicators

In the case of ADAM, the inputs required to carry out the activities will also be analyzed. Some hints will also be gathered on how actors perceive that the system might be improved.

Each of the settings should also include a description of a 'map' of the geographical sites where the activities take place, as well as give an idea of the information flow between distant points.

The analysis of the training process can be as detailed as necessary, by further breaking down the tasks under study. In some cases, a first level of analysis may be enough, while other aspects of the same system will require more refinements, because of the importance given to certain tasks, critical problems detected, etc. It might also be the case that once a first analysis has been completed, a deeper

study is found necessary to clarify subsequent architectural suggestions at the design stage.

It is probably important to clarify the definition of training settings in the organization in contrast to job analysis, because of the reluctance this may create among future users (Buckley and Caple, 1990). Such an analysis is better included within the framework of traditional task analysis techniques (Romiszowski, 1984; Buckley and Caple, op.cit.). It is similar in the comprehensiveness of the work, and it also looks for reported 'areas of difficulty' (Department of Employment definition, 1978) but the aim in this case is rather to explore interactivity and delivery aspects throughout the process which can be supported, enhanced or expanded by the use of Telecommunication services and networks.

A 2.1.2. Analyze the Telecommunication Scenarios

As we have seen when describing the modelling orientation, Telecommunication scenarios represent an abstraction of the settings previously explored within a set of parameters allowing for further matching with telecommunication services and networks.

The components of Telecommunication scenarios are the following:

Information requirements: the kind of information objects which have to be transmitted or communicated. They can be included in the following categories:

Text

Audio

Images, graphics

Pictures

Video: slow motion, full motion

as well as any combination of them.

Grouping of Users:

individual - 1 person

small group - 2-20 people

large group - from 20 people to a mass group

Communication forms: the following types of interaction can be envisaged (Paulsen, 1993):

One-alone (*e.g., access to databases*)

One-to-one (*private mail, videophone*)

One-to-many (*DBS, radio*)

Many-to-many - full interactivity (*Computer conferencing, multipoint videoconferencing*)

Any of these forms can, for their part, be one-way or two-way.

Level of Functionality required: the task can imply different levels of complexity in the communication context. They can be included in the following range:

Simple retrieval - downloading of materials for working off-line

Browsing - possibility of navigating remotely and making choices

Editing - entering and modifying information

Authoring - starting or generating applications on a non-local basis

A 2.1.3. Analyze the matching of Telecommunications Services / Scenarios

The final result of the modelling process is a set of different telecommunications services and networks that may be implemented to meet the interactivity and delivery requirements of the training activities in the system. Several alternatives usually come out at this time, to be studied, combined and selected during the design stage, in order to be integrated into an architectural solution.

A Telecommunications Service may be defined as a set of functionalities with an underlying technological infrastructure which is offered to users as a support to their activities. Several classifications of Telecommunications Technologies are starting to emerge on the basis of their applicability to support human tasks. The work by Grover and Goslar (1993), for example, is claimed to be "one of the first attempts to evaluate empirically this group of technologies" (pg. 167) in the light of users' estimated patterns of usage. Their proposal relies on the concepts of adoption (intention to implement), implementation (actual installation and use) and innovation (perceived uniqueness or novelty of the technology), giving rise to the following classification:

Pervasive technologies: the ones that exist in the organization regardless of any other, as for example, PBX or fax.

Backbone technologies: their implementation tends to be related to the adoption of almost all other technologies, that is, they act as the channel for wider adoption of others. This group would include WANs (Wide Area Networks) or VANs (Value Added Networks)

Advanced technologies: their adoption tends not to be produced in isolation, but rather after less advanced applications have already been incorporated. Examples mentioned by the users were videoconferencing and ISDN.

Other taxonomies place the emphasis on the capacity of the technology to bridge time and distance spannings (e.g., CTA , 1993), establishing the following categories:

Deferred time communications

Remote access to Multimedia Information

Real time communication

A classification of the telecommunication services is proposed here which relies on the concept of **modes of remote activity**. It can be assumed that any scenario in which a person has to perform a task remotely is built around two main dimensions:

- **Communication ends**, or partners involved - people and/or information. This dimension includes to two kinds of service:

Information services - people interacting with information at the other end

Communication services - people interacting with people at the other end

- **Synchronicity** - makes reference to the need for simultaneity of connection of both partners for an effective task performance.

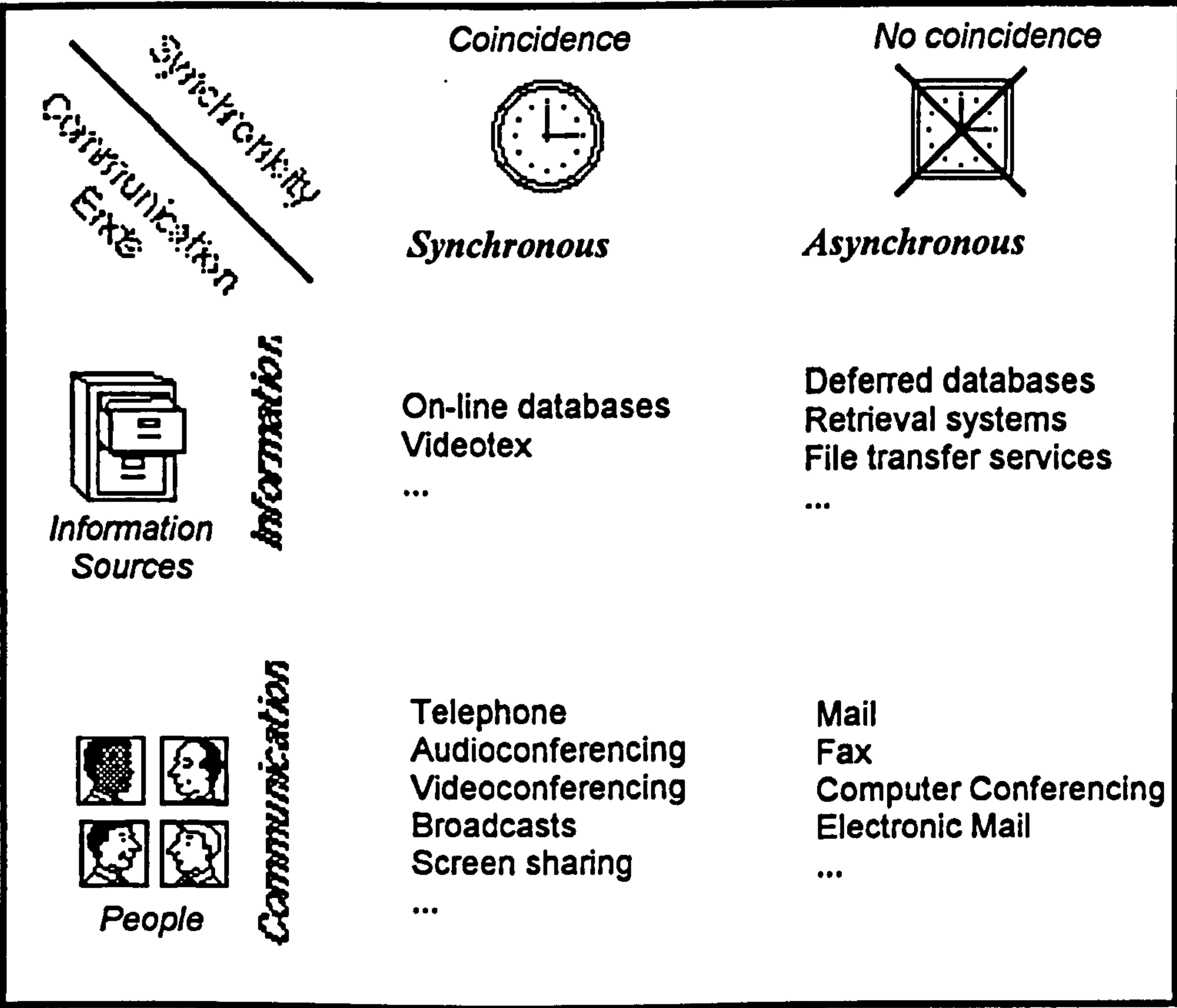


Figure 3.6. Modes of Remote Work and their Corresponding Telecommunication Services

Following this criteria, then, services can be classified as:

- Synchronous*, requiring coincidence in time
- Asynchronous*, not requiring coincidence in time

Figure 3.6 shows the resulting taxonomy of telecommunication services, including some examples for each case.

Step 2.2 - RCO Analysis

A 2.2.1. Analyze TST system Requirements

Requirements - Conditions the system must fulfil

Besides the general objective of supporting the activities defined in the Training settings with technology, the organization usually has a set of conditions that the system must necessarily meet: for example, to be accessible to external users from their homes, to be capable of monitoring every actor's time and activity in the system, to be available in a specific language, etc. These priorities place a first set of boundaries around the design solution, and can be collected by interviewing users and key people during the Training Settings analysis stage. Observation may also be a useful technique, since the designer will perceive the need for some factors that are beyond users' perceptions at this stage.

A 2.2.2. Analyze TST system Constraints

Constraints - Aspects that limit or control the final system architecture

Cost factors are one of the most obvious constraints, as well as the need to make use of already existing infrastructure. Some of these constraints have already been identified at the Context Analysis stage, but a careful detailed description is appropriate at this point.

A 2.2.3. Analyze TST system Opportunities

Opportunities - Added values of the system, new paths that are opened up as a consequence of the introduction of the technology

One of the most common examples of opportunities perceived by users is the possibility of extending the audience of users beyond the current training system coverage. Another interesting example is found in the Internet network, which, besides its main value as an e-mail interconnection, opens up a wide range of new possibilities to those people interested in browsing through the resources offered (Tetzeli, 1994).

Kaye (1993) defines four perspectives that can be adopted in developing a technology-based training system. It can be considered from the point of view of:

- Economic innovation
- Institutional innovation
- Pedagogical innovation
- Technological innovation

An examination of these four perspectives in trying to identify requirements, constraints and opportunities may reveal relevant features through which the architecture should be filtered.

Step 2.3. Cost-Benefit Analysis

The matter of cost benefit analysis is a highly complex one in this kind of context and would require a whole thesis of its own. As Buckley and Caple (1990) state, the field of training is one in which costs are most apparent and benefits more hidden. The difficulty in estimating advantages associated with training applications, or even improvements in performance due to the implementation of a specific programme, makes the justification of investments in training a difficult task. Several authors refer to the lack of a systematic and accurate method of analyzing the costs of Distance Education technology-based projects (Rumble, 1989; Ellerman, 1994).

In fact, a report studying the costs of Open Learning in British organizations (Coopers and Lybrand, 1989), states that it is frequently not just the costing factor that determines decisions on the setting up of innovative training programmes; instead, logistical factors, or merely 'a desire to experiment' are more common criteria affecting a decision to implement this type of project.

However, some way of comparing the performance of the current system and the estimated future outcomes of the TST has to be found in order to justify the costs and effort associated with the introduction of the innovation.

A 2.3.1. Analyze costs (institutional / users)

Unquestionably, an estimation of cost has to find a place within the context of the ADAM approach. The costing issue can have direct implications for final decision-making regarding the project; in fact, it has already been mentioned as one of the most common constraints a TST designer may encounter. Nevertheless, this sort of analysis can turn out to be very useful in increasing awareness of the benefits derived from the TST project. The objective here, therefore, is to match costs in monetary terms with the estimated benefits in overall terms, and make the balance shift towards the latter.

The nucleus of the comparison between face-to-face and Distance or Open Learning in costing terms has been the fixed-variable costs ratio. The feasibility of the implementation of an Open Learning system usually relies on the justification of investment through subsequent compensation in the form of the reduction of costs per student (Rowntree, 1992; Holmberg, 1989). On the other hand, several factors may arise which compensate for higher investments, such as, for example, the recognition of Distance Learning as the only way to reach a specific audience (Coopers and Lybrand, 1989). The search for this kind of element is important in

generating a rationale for the setting up of a TST system, which is usually very resource-consuming. In this sense, Rowntree (1992) suggests that the promoters of these projects turn into 'creative accountants', searching for evidence of benefits, stressing new channels opened up by the new systems, and making suggestions on how to compensate for costs and on how to derive maximum benefit from the resources invested. The search for this kind of information is of more relevance than making a careful, detailed cost analysis (Levin, 1983).

An interesting implication of developing a cost analysis which addresses the different stages of implementation of the system concerns the further distribution of the budget. Marchand and Brulotte (1992) state that, since the accounting system usually reproduces the administrative structure of an organization, each department should have its own budget and relative autonomy over it. This fact makes costs become blurred. A degree of economic commitment is usually required (mostly in terms of human resources) from every group participating in the project, therefore necessitating a study of cost distribution which then serves as a basis for discussion.

Different types of cost analyses can be performed. For instance, Ellerman (1994) distinguishes between the categories of:

- displacement costs, as the benefits resulting from moving from traditional media to innovative ones, and
- added values, as extra facilities arising from use of the technologies (e.g., a concept close to that of the opportunities analyzed in earlier sections of the approach).

A Cost-Benefit Analysis evaluates different alternatives according to a comparison of both their costs and benefits when both are measured in monetary terms (Levin, 1983). Another possibility is a Cost-Utility analysis, in which the

cost of the alternatives is compared to the estimated utility or value of the results obtained.

Within the scope of ADAM, then, it is possible that an appropriate cost indicator for discussion with decision-makers is a combination of a CB analysis of basic concepts, which fundamentally allows for a comparison between face-to-face and TS training, together with an estimation of added values and benefits extracted from the RCO analysis, in a sort of Utility Analysis technique. The main areas of cost (Levin, 1983) may be:

Personnel - full-time, part-time, consultants

Facilities and premises

Equipment and materials

Travel, subsistence, etc.

Other costs

This analysis may serve as a basis for discussion with the project team regarding the sort of parameters that usually merge when analyzing training costs. On the other hand, even though experts warn of the risks of subjectivity in Utility analysis (Levin, 1983), the sort of objectives pursued by organizations and the inherent nature of the adoption of the innovation process (Rogers, 1983; Lee, 1991) possibly make this kind of analysis sufficiently useful when justifying investment in TST in an organization.

An important point to be made at this juncture is that the cost analysis performed here represents only a broad estimation of resources within a time range. In fact, this stage analyzes different alternatives with a view to the future. Therefore, references to the large scale future implementation of the system will find their place in this analysis, but only in general terms. In fact, the ever changing commercial market of technology products would not allow for an accurate

estimation of costs in the long run. Conversely, a fine-tuning of costs is subsequently performed when a budget is drawn up for the implementation of pilot projects.

A 2.3.2. Analyze benefits (institutional / users)

The TST designer will have to explore and come up with the benefits of the organization under study, that will be set against purely comparative costs in order to justify investment and to get a green light for the project.

As a sample, a recent study collecting and evaluating a compendium of 101 accounts of success stories in the application of Technologies to Higher Education environments (Boettcher, 93) states the following factors as estimated benefits at different organizational and technical levels:

- **Benefits for students**

- better understanding of materials
 - increased enthusiasm and interest in learning
 - ability to access materials at a convenient time and place
 - ability to review as much as necessary
 - possibility of getting fast feedback

- **Faculty benefits**

- improved relations with students
 - increase in communication with colleagues about academic matters
 - heightened pedagogical interest and concern in teaching
 - reinforcement of material presented in class
 - improvement in performing routine administrative tasks

- **Department benefits**

increased recognition or enhanced reputation

more efficient use of resources

increased ability to cope with high enrolment

the provision of a showcase for visitors

possible generation of external grants

- **Institutional benefits**

acquired or improved reputation

improved marketability of graduates

greater attractiveness of the institution for new students

improved communication among faculty / departments / students

perceived as a step towards information technology pervading campus life.

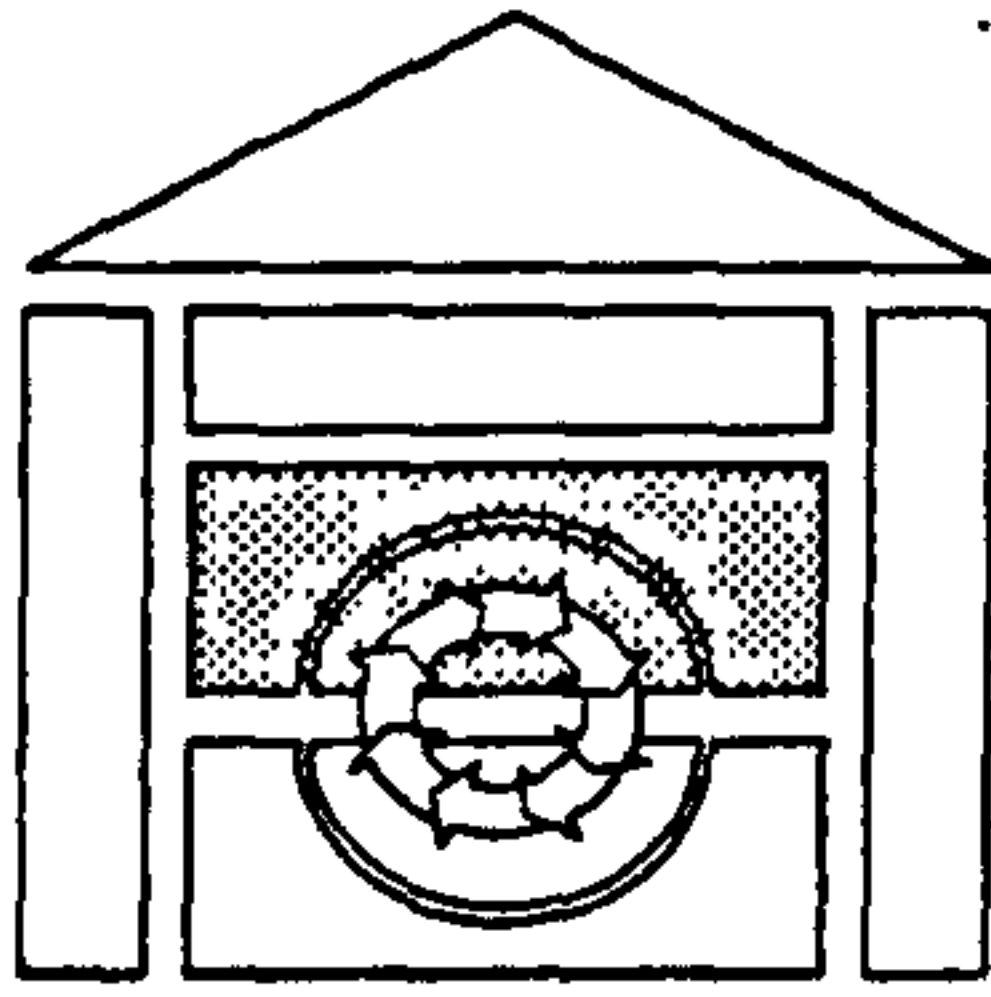
Stage 2 - Deliverables

A TST system model is a product of Step 1, in that it provides a range of Telecommunication Scenarios that are matched with training activities. Several architectural solutions will be possible as a result of this model. These will be studied and the most suitable one will be selected during the initial steps of the next stage, TST system Design.

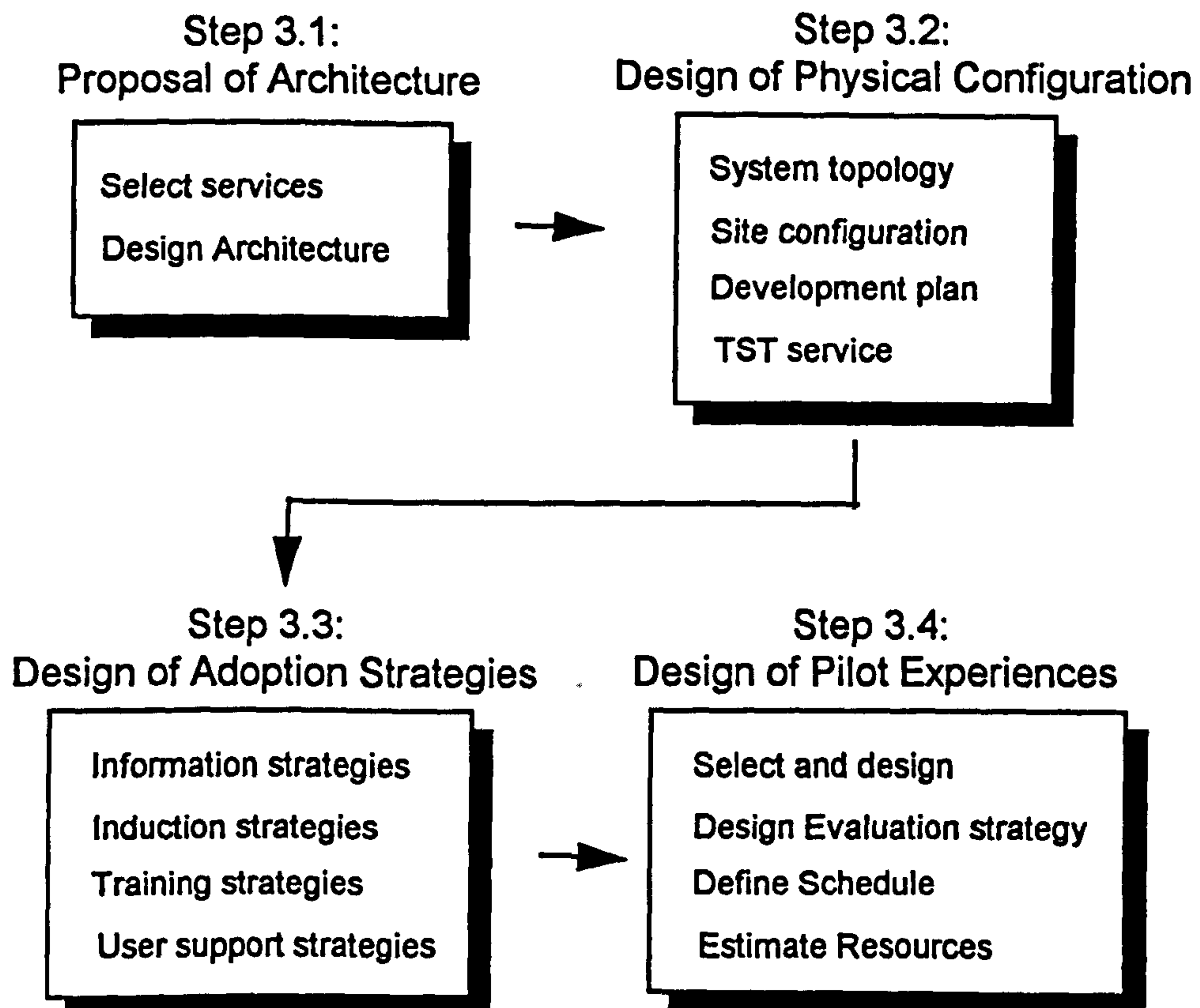
A report on RCOs and cost-benefit will also be produced at this stage. The criteria and elements stated in the report will modulate architectural and other design decisions in the next stage.

Stage 2 - Roles involved / Techniques recommended

The project team is responsible for this sort of analysis, through a detailed programme of interviews and group meetings with key users which provide information on the current training system and how it might be improved through the introduction of Telecommunications. The combination of technical and educational skills is important in adopting a multidisciplinary approach to the analysis stage.



3.6.3. Stage 3 - TST System Design



Objective: Define and put forward a Telecommunications Architecture that
meets specified requirements,
avoids identified constraints,
creates opportunities and
is acceptable to decision-makers

The Telecommunication Services, filtered through the results of the RCO and cost-benefit analyses should give rise to a proposal of a technological architecture, in terms of Telecommunication services, networks through which they should run,

and their corresponding actors, media and organization. Once the generic solution has been decided, three further design steps have to be taken: to construct the physical detailed configuration of the architecture, to formulate the Adoption Strategies to be implemented for a successful introduction of the TST system into the organization, and to select and plan a set of pilot experiences that will test the design and consequently set the basis for the consolidation of the system.

Step 3.1. - Proposal of Architecture

A 3.1.1. Select Telecommunications Services

The modelling process has given rise to a range of possible Telecommunications services that may be implemented in any given context. On the other hand, the analysis of RCOs and the cost-benefit provides the designer with the clues to modulate the selection of the final solution. This activity is oriented to the selection of the most appropriate option.

A 3.1.2. Select architectural solution

The final design of architecture should be specified in this activity, with a justification for the selection. It will be described in terms of the components shown in Figure 3.1, that is: the key contextual aspects, the media to be used, the types of actors involved in the use of the system, and the telecommunications services and networks underlying and supporting their activities.

Step 3.2. - Design of Physical Configuration

The activities carried out during this stage are of a technical nature. Their aim is to define in detail the configuration of the network through which the supporting

services will run, including the topology, the capacity and the technical configuration of the nodes and sites that will access it.

A 3.2.1. Design the architectural topology

The architecture defined in generic terms now has to undergo a further design process in which the detailed physical topology has to be defined: how many sites will be covered and which type of network will link them?. Potential access sites will also be defined here: users will be able to connect from home, from classrooms at their schools, from their rooms, etc. Any network components already existing will be taken into account, in order to optimize investments that may already have been made.

A 3.2.2. Design configuration of the sites

Along the same lines, the sites linked to the network will have to be described in terms of their technical configurations. Equally, the design will take into account equipment already existing in an attempt to optimize its use and integrate it as a part of the architecture.

A 3.2.3. Design purchase / development plan

Once the above parameters have been defined, a plan to acquire the necessary infrastructure has to be made. Several alternative courses of action can be considered here: to purchase products or to develop the company's own (in which case a 'make or buy' decision has also to be made), or to pursue a mixed strategy by which commercial products are in some way adapted to customize the ultimate users of the organization (e.g., the translation of commands and interfaces, or adaptation to an already existing configuration). Time considerations are important in making this decision, especially if developments

are to be made. Finally, the gradual implementation of the different services is also studied in detail during this activity.

A 3.2.4. Design the service

An interface has to be built over the technology already implemented, capable of transforming it into what the users perceive as a service. In the case of e-mail, for example, users would expect to find initial screens with introductory messages, mailboxes and accounts already open, etc. The same applies to LANs, databases, computer conferencing, etc. Another kind of tools would also imply the development of a 'sense of service identity', that integrates all the applications and offers an integrated image of the TST system. A name for the different services and/or system is usually created too, as a benchmark for users. This task involves both technical and organizational aspects.

Another point related to the description of activities, however, refers to the possible new roles that may emerge in the organization in the context of the introduction of the TST system. The figure of facilitator, for example, has acquired significance in association with Computer Conferencing and fills the need for a leader (Hiltz, 1988; Mason and Kaye, 1989) in such a distance group communication environment. In the same way, the role of technical supporter, and even that of the own Change Agent, emerge as new figures who will have to be taken into account during the design of the system if it is to be maintained over time.

The same applies to the case of technical maintenance. A support desk (which in this case is purely technical, and which should not be confused with the users' support contemplated as an adoption strategy) has to be established to deal with any technical problem that may emerge once the system is actually operating.

Step 3.3 - Design of Adoption Strategies

Four different levels of Adoption strategies should be examined at this point. They are determined by three parameters: the size of the audience, the type of information provided about the system / service, and the sort of deliverables best suited to meeting the corresponding objectives.

A 3.3.1. Design Information Strategies

The objective here is to make as many potential users as possible aware of the creation of the TST system, stating its characteristics at an advertising level. Technical aspects are only covered with regards to the conditions for accessing the system, so that those interested can assess the possibility of using it.

A 3.3.2. Design Induction Strategies

In this case, the aim, at a deeper level, is to familiarize potential users with the functionalities of the services and the types of applications that could be useful for their particular training-related situation. The potential user, once aware of the existence of the service, approaches it with a view to exploring its usability and usefulness for his/her specific needs. Deliverables produced at this level should include induction sessions, demonstrations of the system's functionalities, brochures, etc.

Adoption Level	Objectives	Audience addressed	Contents	Deliverables
INFORMATION	Raise awareness on the existence of the service	Wide - Any potential user	General info on: Creation of the system Conditions to use it Basic functionalities	Brochures Conversations, contacts Information sessions
	Introduce to system's use - costs and benefits of their use	People interested from the former level asking for further information	Conceptual model underlying technology Scenarios adequate for implementation Demonstration of use	Induction sessions F-t-F Demos Group meetings Introductory papers
TRAINING	To prepare users to incorporate the system to their activities	People starting to use the system Actors related to the experiences	Deep content level: Navigation (basics and advanced) Organizational aspects Pedagogical exploitation of the tool	Training sessions F-t-F Hands-on practice On-line training User Guides
	To monitor and encourage users in their TST supported activities	Any user of the system	Just-in-time tutoring, both for technical and behavioural questions	On-line desk Hot-line for problems Monitoring of drop-outs and users in general

Table 3.1. Adoption Strategies: levels and features

A 3.3.3. Design Training Strategies

The target group for this level is composed of users who have already taken the initiative of using the system. Consequently, the level of knowledge transmitted is much deeper, covering all the aspects described above: how to connect, navigate and perform new tasks and habits generated as a result of the adoption of the system. This type of action should never be taken until users have their infrastructure ready for connections. Larger sessions and small groups are organized in this case, since individual practice with the system is required. Two categories of training are considered, given their qualitatively distinct nature:

- *Training in the use of the system* - revision of functionalities, connection procedures, commands and basic actions with the system
- *Training in the pedagogical exploitation of the system* - teaching aspects and how to cope with them through the system: training management, monitoring of groups and individuals, additional materials required and adaptation of the existing ones for a given course, estimation of time and effort to be devoted to each of the stages, students' requirements, etc.

A 3.3.4. Design user support strategies

A support desk has to be set up so that users have a permanent contact point for any problem they may come across, either technical, educational or organizational. The most usual strategies are telephone hotlines and on-line consultation desks.

The Adoption Strategy levels, summarized in Table 3.1, include examples of the deliverables produced as a part of every strategy.

Step 3.4 - Testing of Architecture (I): Design of Pilot Experiences

The objective pursued in carrying out pilot experiences is to test the suitability of the designed architecture, both concerning technical specifications and adoption strategies. This means that their selection and design have to be carefully completed, in order to identify those factors that may determine the successful consolidation of the system. Conversely, an evaluation framework based on such factors has to be developed, in order to come up with a set of consistent conclusions. Finally, the experiences have also to be integrated into an 'experimentation plan', and resources necessary to run the project must be estimated.

A 3.4.1. Select and design experiences

At this point, a set of testing criteria should be drawn up, in the light of the proposed design. The experiences will cover some of these criteria, or may test an overall approach to them. But in any case, they should be designed with the aims of demonstration and the provision of feedback on the suitability and feasibility of a possible large-scale implementation of the architecture.

Other factors are important in selecting of the pilot experiences, e.g., the audience and area addressed, the scope of dissemination of the results, etc.

A 3.4.2. Design evaluation strategy

Along the same lines, a common evaluation framework has to be developed for the experiences. The basis for this has already been discussed in relation to the concepts of Adoption and Acceptance, and the outline of the framework is shown in Figure 3.7.

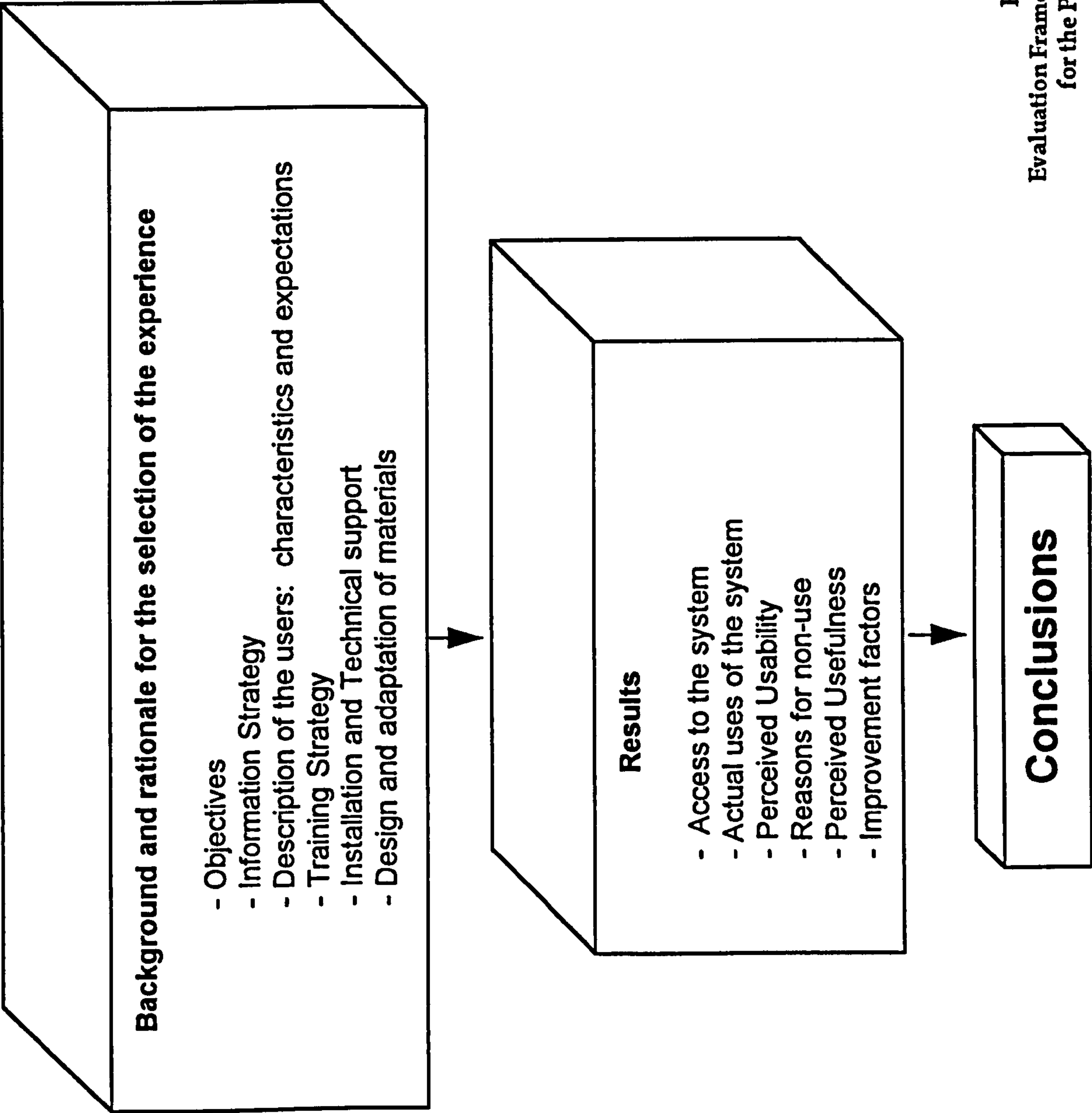


Figure 3.7
Evaluation Framework defined by ADAM
for the Pilot Experiences

The framework is structured into two categories, following Remenyi and Money (1991) model, which establishes the degree of expectations vs. performance as a measure of satisfaction.

Evaluation of the setting-up process. This is intended to explore of the infrastructure implemented as well as the strategies and resources applied to create the conditions for training to take place.

Evaluation of results, in terms of acceptance and the degree of adoption of the TST system. The variables used in this case are based on Kerr and Hiltz (1982): attitudes towards the task / towards the media, accessibility, actual uses of the system, perceived usability, perceived usefulness, reasons for non-use, estimated improvements to the system

A 3.4.3. Schedule experiences

This activity will cover the development of the overall planning for the implementation and evaluation of the experiences.

A 3.4.4. Estimate resources

A budget plan for carrying out the experiences has to be designed as well. Two main approaches are adopted for this estimation of resources:

a global one, considering the design of an architectural sub-system, capable of coping with the development of the experiences while avoiding unnecessary expenditure, and

a specific cost approach associated with individual experimentation (especially if different factors are addressed in each case)

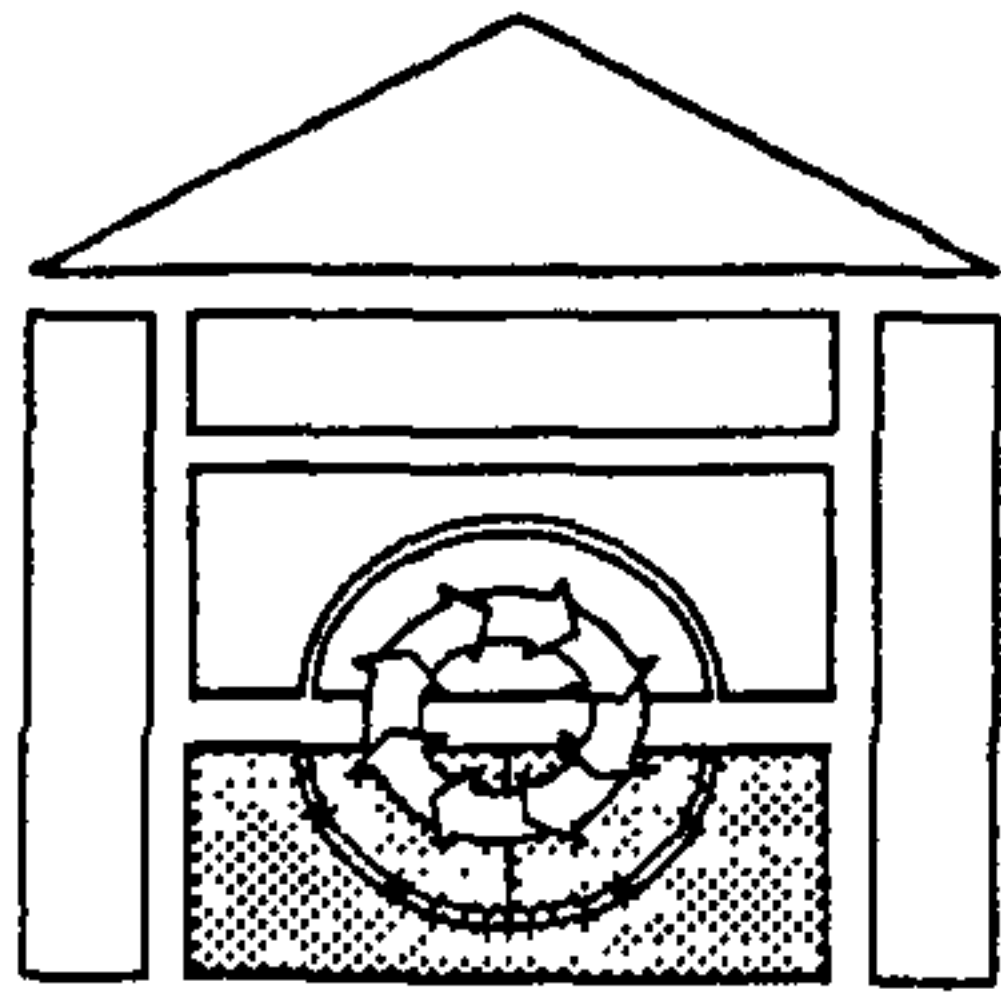
A final budget will be drawn up for submission to the appropriate management.

Stage 3 - Deliverables

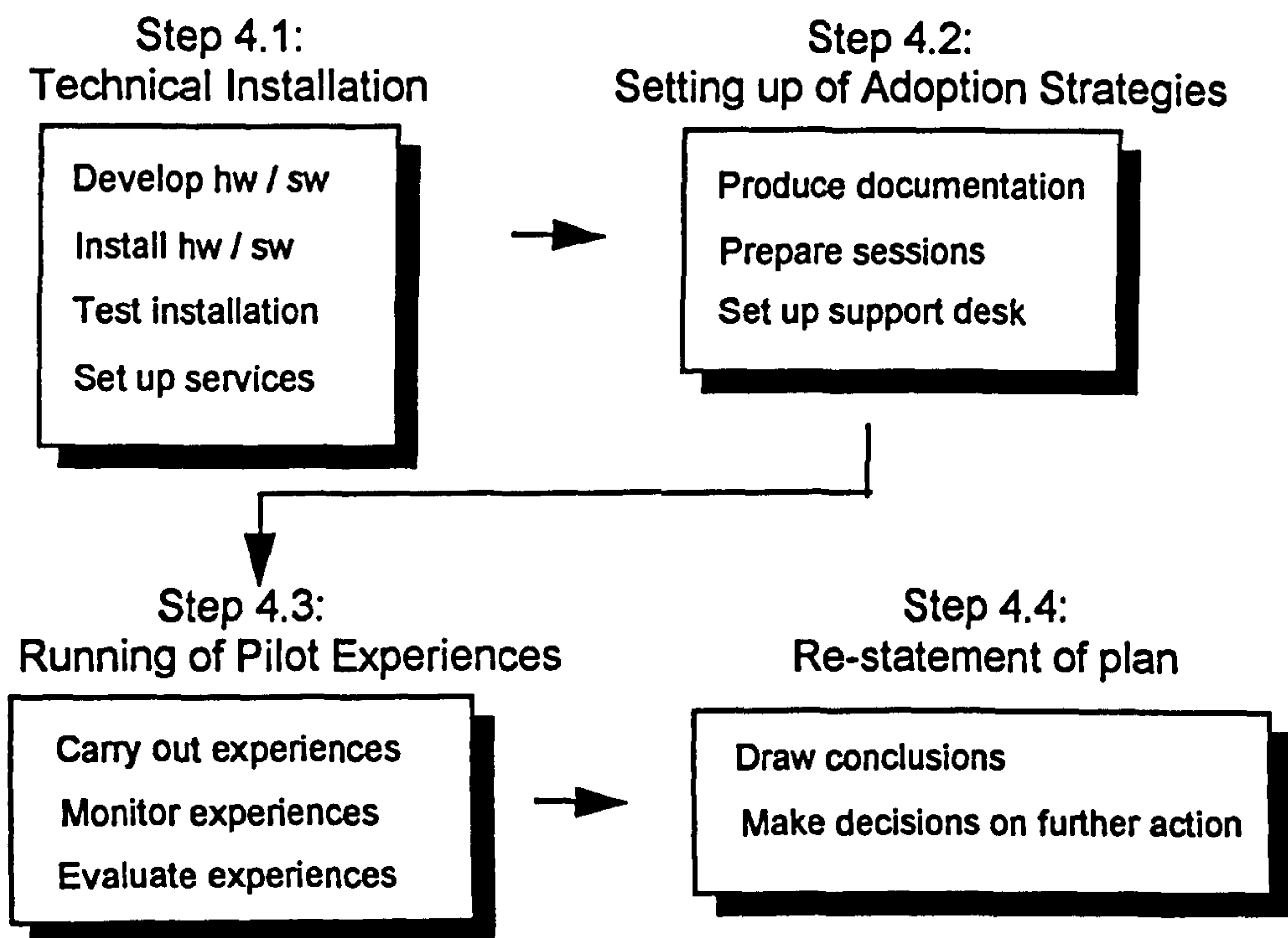
An integrated deliverable emerges from this stage in the form of an **Implementation Plan**, which serves as a basis for the next stage.

Stage 3 - Roles involved / Techniques recommended

The design stage covers the most important activities performed within the ADAM framework. The balance between architectural elements (technical components and adoption strategies) is essential for the proper design of the system. It therefore requires the joint effort of the whole team. Finally, the selection and design of the pilot experiences also involves coordination with potential users of the system.



3.6.4. Stage 4 - TST System Implementation



Objective: To implement the architecture designed at the previous stage, and come up with conclusions for a further re-statement of this design.

This stage covers the implementation of the design completed during the previous one. It deals with the installation of the telecommunications services and networks selected in the architecture, as well as with the setting up of the adoption strategies designed. Once both infrastructures are ready, a third step consists of actually carrying out the pilot experiences. Finally, conclusions and recommendations are established, leading to the re-statement of the design and/or the implementation plan on a larger scale.

Step 4.1. - Technical Implementation

A 4.1.1. Develop / purchase hardware and software

This activity covers a typical hardware and software acquisition process. In cases where a decision is made to develop software internally, a software engineering standard model is recommended, this aspect falling beyond the scope of this section.

A 4.1.2. Install hardware and software

Development of the installation process, both for the central service infrastructure and for the user sites, following the previous design steps.

A 4.1.3. Test the installation

The infrastructure has to be working properly before any users access to it, even for demonstration or training purposes. A painful experience with the technology in the early stages of the adoption process could bring about negative consequences for the consolidation of the architecture. This means that exhaustive testing and validation of the technical implementations have to be made in advance.

A 4.1.4. Set up services

The service will be implemented at this point according to the design completed at the previous stage.

A 4.1.5. Plan maintenance and support

This aspect of the system has also been covered during the design stage, and will be implemented by following the guidelines already laid down.

Step 4.2. - Setting up Adoption Strategies

A 4.2.1. Produce the documentation

Any type of documentation should be prepared in order to support the adoption strategies: leaflets, papers, guides, etc.

Instruments of assessment are also developed at this stage: questionnaires, interview scripts, logs, etc.

A 4.2.2. Prepare induction and training sessions

Equally, the sessions at the induction and training levels will be produced along the design in a highly attractive way.

A 4.2.3. Set up the users' support desk

Implementation of the designed services: hotline, on-line consultation, etc.

Step 4.3. - Testing of Architecture (II): Running of Pilot Experiences

A 4.3.1. Carry out experiences

Follow the implementation plan developed at the Design Stage.

A 4.3.2. Monitor experiences

The close monitoring of the experiences, data collecting procedures, etc., along the lines of the evaluation framework.

A 4.3.3. Evaluate experiences

The experiences will be assessed in order to draw up a set of conclusions and recommendations to be discussed by the project team.

Step 4.4 - Re-Statement of the Plan

A 4.4.1. Draw conclusions from the evaluation process

This activity constitutes matching the evaluation results with the test criteria defined at the design stage. Discussions should be held regarding the suitability and validity of the proposed architecture and the need to modulate it for implementation on a larger scale.

A 4.4.2. Make decisions on further actions

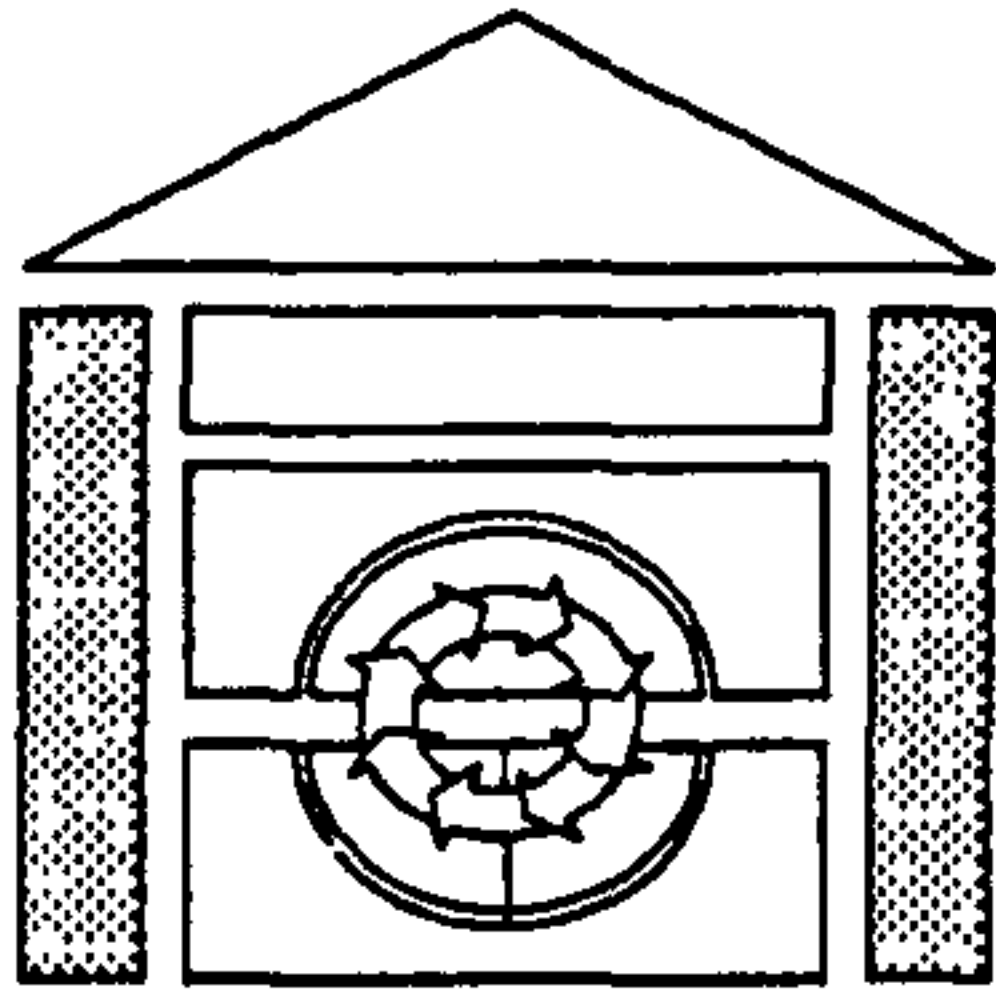
Recommendations will be made regarding the extensive implementation and consolidation of the TST system designed.

Stage 4 - Deliverables

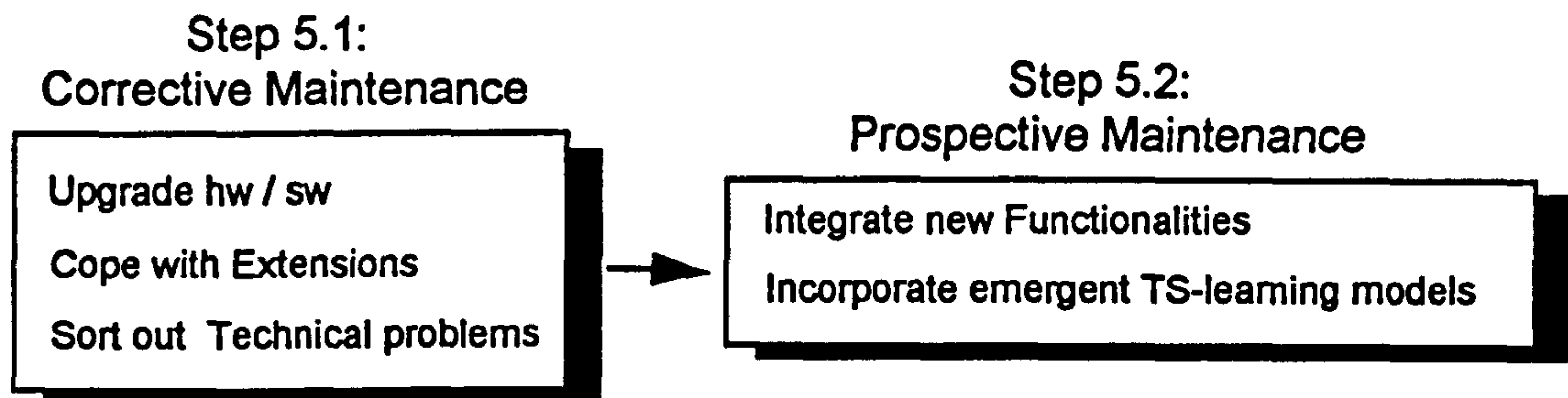
An evaluation report on the experience, introducing amendments and making recommendations concerning the Design stage.

Stage 4 - Roles involved / Techniques recommended

The implementation of the experiences is a highly collaborative task involving all the project team members as well as users of different types (learners, teachers, administrators, managers, etc.). The project manager is responsible for coordination and the eventual compilation of the evaluation report.



3.6.5. Stage 5 - TST System Maintenance



Objective: To establish a mechanism for setting the system whenever it operates, and a procedure to cope with emerging innovations in the field.

Once the TST system has been tested and decisions have been made regarding its consolidated implementation, a maintenance mechanism has to be designed and installed. This sort of system requires the setting up of maintenance in two dimensions: *corrective*, in an attempt to cope with new technical developments, and *prospective*, searching for the enrichment of the system by incorporating new services, functionalities and educational models that will inevitably emerge in the future. Both mechanisms seek permanent feedback at different stages of the process.

Step 5.1 - Set up corrective maintenance

A 5.1.1. Upgrade the hardware and software in use

Every technology-based system must permanently deal with upgrades, if it is not to become obsolete in a short period. Moreover, networked architectures imply a

complex process of harmonization of the different applications installed in the system. This activity is oriented to achieve an effective mechanism for dealing with this sort of problem.

A 5.1.2. Cope with extensions of the TST system

Equally, an increasing number of users results in qualitative extensions over time, requiring a study in advance and the corresponding feedback to the architectural design.

A 5.1.3. Sort out technical problems

This activity covers the permanent support that was designed at the implementation stage (A 4.1.4), but which in this case is extended to the large-scale operating system.

Step 5.2. - Establish Prospective Maintenance

A 5.2.1. Integrate new functionalities

New telecommunications services are emerging from the rapidly evolving world of ITT, bringing new functionalities that have to be permanently monitored. Their suitability and the cost of implementing them in the TST system currently operating have also to be studied, and in the case of positive decisions, the architectural design may be changed to incorporate them. The corresponding loop of pilot experiences will start again in case substantial amendments are made to the architecture.

A 5.2.2. Integrate emergent TS-learning models

It has already been stated in previous sections that new learning environments are emerging as experimentation and research is carried out in this field. Such new concepts also have to be evaluated in order to integrate them and improve and adapt the architecture to 'educational updatings'.

Stage 5 - Deliverables

The outcome of this stage is a mechanism which guarantees that: (i) the system operates to achieve the established objectives and is able to cope with any problems that may arise, and (ii) the system is permanently enriched with new developments, both in the technological and the educational fields.

Stage 5 - Roles involved / Techniques recommended

The whole project team is obviously involved at this stage, as are all the actors using the system. A new role, that of TST coordinator, should possibly emerge from within the organization as the one looking for innovations and coordinating both the maintenance and the operation of the system.

3.7. The Testing out of ADAM: Evaluation Criteria

In the two following chapters, a testing of the ADAM approach will be made, with a view to discussing its power both for designing TST systems and for analyzing already-existing ones. A set of criteria for the evaluation of the approach will be made, that are directly derived from the design, are defined as follows:

The approach should be able to detect relevant contextual factors having further incidence in the design.

The approach should be able to identify the impact that the new system will have on the users, and accompany the necessary procedures for overcoming implementation barriers.

In taking the TST model as a theoretical basis, the approach should be user-oriented

The approach should provide a structured procedure for teamwork, facilitating the creation and operation of multidisciplinary teams.

From a research point of view, the approach should be able to increase the understanding of how a TST operates, thus expanding the knowledge base in the field

The approach should be useful both for designing new TST systems as well as for analyzing already the existing ones in the real world.

Chapter 4

ADAM as an Analysis Tool: Multimedia TeleSchool (MTS) Project

4.1. Introduction

4.2. The Use of ADAM as an Analysis Tool

4.3. Analysis of the MTS TST System

4.4. Implementation of MTS on User Organizations

4.5. Conclusions

4.1. Introduction

The objective of this case study is to show the capacity of the ADAM approach to analyze an already existing TST system, to propose alternative architectural solutions and to make recommendations for improvement. We will deal with a project developed under the auspices of the R&D DELTA Programme, the Multimedia TeleSchool (MTS).

As MTS is a research project, there are a number of factors that may interfere with its functioning, in contrast to a corporate or commercial, non-research TST system. Consequently, several points should be made regarding this case and its significance in terms of this thesis:

- The MTS project is currently the largest sponsored by the DELTA Programme. As we will see, it delivers training courses through innovative, telecommunications-supported media to a large audience of professionals in corporate and educational environments. As a funded project, it is certainly influenced by external forces (political, social, etc.), in contrast to a hypothetical equivalent project working on a commercial basis. On the other

hand, its R&D, innovative character has also brought about a different approach to problems from that adopted for the methodology proposed here. Nevertheless, from its inception, the project has had a market-oriented, realistic approach, and, in this sense, it represents an appropriate case study for our purposes. This exercise, therefore, was designed to make a constructive critical analysis, considering the MTS project as it will be in the near future, that is, a commercially available training network at the service of companies and training institutions.

4.2. The Use of ADAM as an Analysis Tool

A highly interesting aspect of this case study is the conception of MTS as an *already existing TST system offered on an open basis to external users*. As we have already stated, the ADAM approach assumes that contextual factors have a vital influence on the design of the system. Along these lines, the analysis of a nonexclusive TST architecture having to adapt to specific organizational contexts rises a set of research issues that could enrich available knowledge of these systems, and therefore shed some light on the research questions posed by the present work.

The analysis will be made in the following way. Firstly, the MTS system will be modelled according to the principles of ADAM, and the emerging architecture (technical components and adoption strategies) will be compared with the actual one. Through a brief discussion of the results found during the implementation of MTS in two large organizations, conclusions will be drawn concerning the solutions proposed by the architecture of ADAM.

This analysis framework for the MTS case is shown in Table 4.1. As we can see, only certain parts of the ADAM approach have been used, their selection

depending on the specific system under study. It is precisely in this way that ADAM reflects the Soft Systems perspective underlying its development, in that it does not offer a rigid set of prescriptions but merely a series of recommendations for analysis, design and action that can (and in fact should) be checked against contexts in the real world. The modelling process is therefore performed on the basis of the available information about the system, in order to organize thinking about the subject. The suitability of the ADAM approach in performing this kind of analysis is discussed in the closing section of this chapter.

<p><i>Analysis of the MTS system using the ADAM Framework</i></p> <p>Analysis of the MTS system MTS Context - General features and background MTS System Analysis - Modelling: Training Settings Telecommunication Scenarios Requirements of the System Selection of Services Comparison of ADAM model and the actual MTS system Conclusions</p> <p>Analysis of the implementation of MTS in two User Organizations (UOs) UO1. A Spanish Banking corporation: Organization of the MTS courses User acceptance and use of the technology UO2. Successful implementation on a German company: critical factors</p>
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Table 4.1. Framework for the analysis of the MTS System

4.3. Analysis of the MTS System Architecture

4.3.1. General features and structure

The Multimedia TeleSchool project came into being in the context of the EC R&D DELTA Programme. Its main objective is to develop a trans-European, telecommunications-supported training network for the delivery and operation of courses directed at corporate professionals. The project was set up by a

consortium of different European institutions specializing in course design, production, delivery and the evaluation of training courses.

This first stage of the project covers the years 1992-94, and the main aims are (MTS Annual Report, 1993):

- To evaluate the effectiveness of the concept of a Multimedia TeleSchool in corporate training environments, and to assess user acceptance in these settings
- To stimulate market uptake of Telecommunications-based learning products and networks

The idea underlying the project is to create a European Training Network, in which any course manufacturer can input their products, and learners and learning organizations can apply for any of the courses. The network would then provide clients with training materials, course tutoring and support for the use of the telecommunication tools used. The use of technologies is intended to enhance and augment the interactivity of distant learners and improve the exchange of course-related information. As for the experimental stages of the project, a group of evaluators is drawing up conclusions and recommendations that may assist further implementations of the above network on a larger scale.

Work on this project started in 1992. More than a thousand learners at 60 different sites in 13 European countries have so far participated in the trials. Courses deal with several areas of knowledge, mainly languages (especially English for different professional environments), Environmental Sciences, Agrofood and Telecommunications.

The project partners are structured by following functional criteria. As a result, there is a group of course providers, who input courses in different formats using several media (printed matter, audio, video). There is also a group of technology

providers, contributing telecommunications services, mainly Computer Conferencing and Direct Broadcast Satellite (DBS). As the network is only intended to cover different aspects of telecommunications, and as it is being applied with a view to the future (switching from PSDN to more advanced and powerful networks, such as ISDN), any other support or medium used should be dealt with by the appropriate course provider.

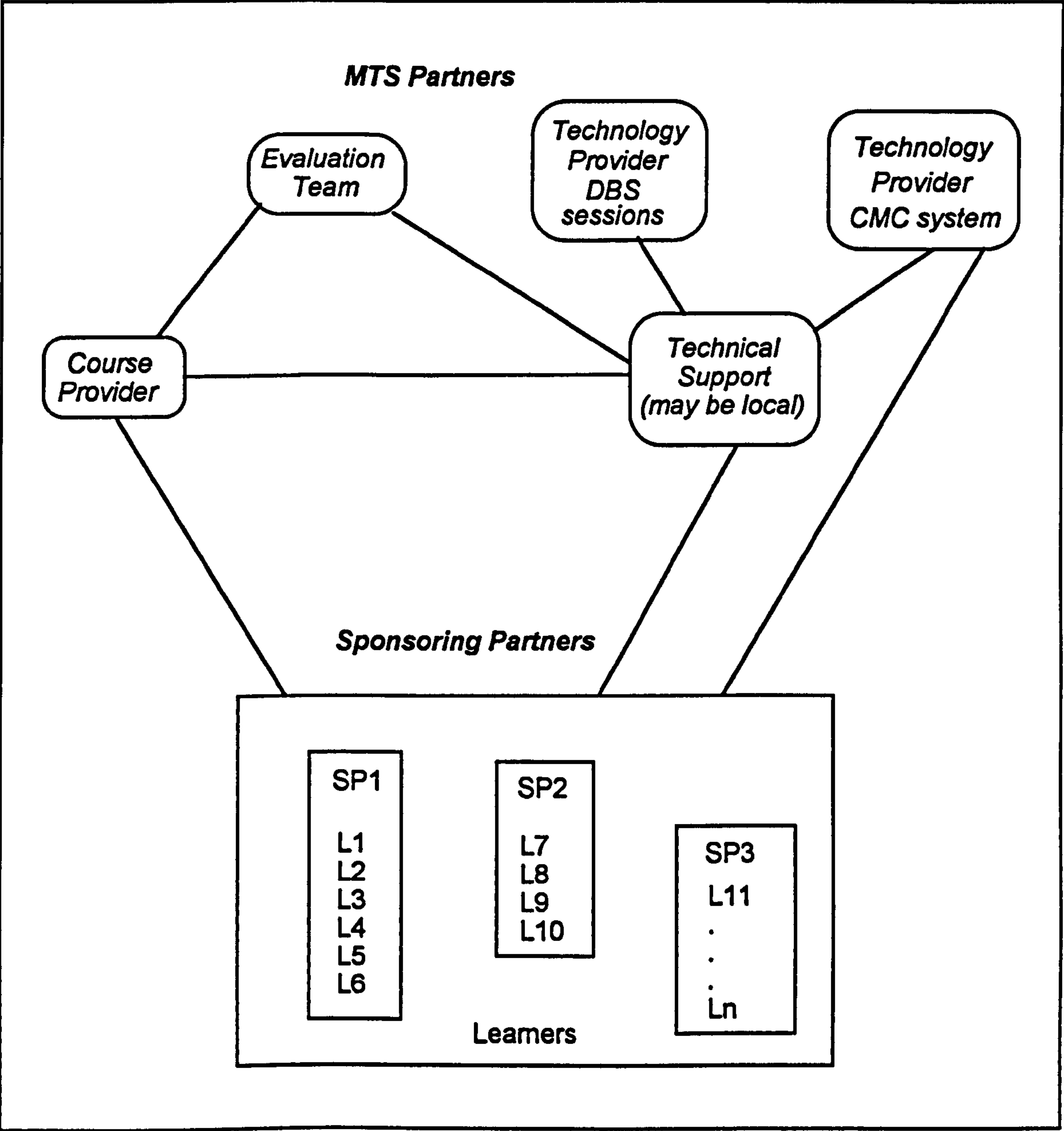


Figure 4.1. Multimedia TeleSchool Project: Organizational Structure

Figure 4.1 shows the structure of the MTS network schematically.

Course materials consist of the following combination of media: printed matter (set books, study letters or course guides, leaflets), audio and/or video cassettes and on-line exercises through the CMC system that learners download as print-outs to work off-line. Some of the courses also contain software packages for self-study practice. All the courses include live broadcast sessions every fortnight which, by connecting all learner groups involved in the same course, promote interaction among the groups concerning specific discussion topics and exercises. The sessions combine the use of TV, CMC and increasingly advanced telecommunication devices (videophone, videoconferencing through ISDN) to experiment with contacts among the actors. Other more traditional media (telephone tutoring, fax) may also be used.

A remarkable feature of the system is the distance between the different partners in the consortium. This means that the management of the network is highly distributed. On the other hand, there is a set of partners who run local training sessions for the users to get to grips with the system and who provide them with technical support throughout the course. These partners, as well as the project evaluators, are also spread throughout several European countries.

4.3.2. Training System Modelling

- ***Roles involved in the MTS System***

To make this analysis we omitted those aspects regarding the context in which MTS is operating at the moment, that is, its involvement in the DELTA programme and the corresponding functions and responsibilities carried out in relation to the EU. MTS is explored as a commercially-available training network, as it is intended to be in the future.

PHASE	ACTIVITY	ROLES INVOLVED	INPUTS	OUTPUTS
1. Course Design	1.1. Adaptation of course materials to the MTS media	Designer (from course provider) TV production expert CMC expert	Traditional distance learning course materials: printed matter, audio, video cassettes	Adapted materials' design: printed matter, course guidelines, TV scripts, on-line exercises and practices
2. Marketing activities	2.1. Elaboration of marketing products and materials	Marketing expert MTS management Designer (from course provider)	MTS marketing policy Knowledge of course contents and dynamics	MTS brochures, flyers, promotional videos
	2.2. Running of dissemination sessions	Marketing expert MTS management User organization's representatives	Discussion of MTS network possibilities and conditions (cost, infrastructure, etc)	Potential client Agreement on collaboration
3. Course enrolment	3.1. Submission of applications and selection of learners	Local coordinator Learners Course provider's administration	Applications, tests sent to potential learners	Selection of final group
	3.2. Registration	Local coordinator Course provider's administration	Submission of invoices, registration conditions	Learners formally registered in the MTS network
4. Course development	4.1. Development of the on-line environment	Tutor (from course provider) CMC technical support	course design	CMC on-line working environment (MTS Electronic Classroom)

PHASE	ACTIVITY	ROLES INVOLVED	INPUTS	OUTPUTS
	4.2. Development of TV programmes	Tutor TV production team Content experts	TV scripts	Live TV programmes to be broadcast through DBS
	4.3. Development of complementary materials	Tutor Specialists from course provider	Course design	Course guides, instructions, study letters, etc.
5. Course delivery	5.1. Delivery of basic course materials	Course provider Learner Local coordinator	Set of personalized materials (user IDs, etc)	Learner ready to access to the network
	5.2. Delivery of induction sessions	Local coordinator Local technical support (if available; if not, support from technology provider) Learners	Instructions for use of the media and course dynamics (methodology, working schedule, exams and qualifications)	Learner ready to start course
6. Course use	6.1. Pedagogical setting A: Asynchronous virtual classroom	Learner Tutor Course Peers	Course contents Materials delivered On-line exercises within the environment	Corrections to exercises, on-line discussions, peer communication
	6.2. Pedagogical setting 2: Live virtual classroom	Tutors Learners Content experts TV production team Local coordinators	Real-time running of classroom sessions	Documentaries, discussions with experts, live questions and answers, exercises

PHASE	ACTIVITY	ROLES INVOLVED	INPUTS	OUTPUTS
	6.3. Pedagogical setting C: self-study	Learner Tutor	Course materials	Exercises, reading of materials, practice with other self-study media
7. Evaluation	7.1. Collection of evaluation material	Evaluators Local coordinators Tutors Learners	Questionnaires In-depth interview scripts Strategies for gathering course running information	Knowledge about implementation, users' acceptance and pedagogical adequacy of course
	7.2. Communication of evaluation results	Evaluators Tutors Course providers Technology providers MTS management	Evaluation reports	Formative evaluation, changes and new developments in further courses
8. Project Management	8.1. project Management Meetings	One representative of each project partner (at least)	Reports on the course of the project in its different working lines	Decisions on further actions, strategic yearly plans
	8.2. Monitoring of project progress	As many partners' actors as possible	Problems, new ideas, initiatives on project progress	Modifications, improvements "on the move"

Table 4.2
 MTS System: Training Settings

For supervision purposes, both course and technology providers form a management team, who discuss the structure of the network, the type of courses to be delivered, the technology that will be used (especially concerning future developments), changes in the strategic plan, etc. In the same way, this management team makes sure that courses are keeping to schedules, and that users are satisfied with the system performance. A part of this team is also responsible for the coordination of marketing at the two levels described above (new learners and new course providers).

Even though courses have already been completed when they input the system, there is usually a need for a set of designers to adapt some aspects of the materials in order to match them with network requirements. This role is usually performed by the project coordinator on behalf of the course provider (who may be a content expert or the person directly involved in the development of materials for the original distance course), together with a team of technical staff from the CMC and TV providers, who help to design scripts, on-line activities, etc. As a framework for these tasks, some of the project technology providers have developed a set of deliverables studying the most adequate pedagogical scenarios and strategies to be applied both with CMC and DBS (MTS Consortium, 1992; Phelan, 1993).

Tutors play a very active role in the system. Their work is seen as crucial to the involvement of the learners in the telecommunications environment. A group of tutors is named by every course provider, the size of learning groups determining the number of tutors. The latter have to run the course in the different modalities, and carry out traditional counselling functions, adapting their interactions to the new media, and monitoring the students as closely as possible.

The final users of the system, the learners, are expected to belong to large organizations with very different training systems. The typical learner addressed

by the system is a corporate professional having to meet on-the-job training requirements. Some previous experience with computers is desirable, but not necessary. The learner should have a positive view of international or cross-cultural collaboration.

According to project organizational factors or decisions made by the client, local coordinators may be named for each country. They act as contacts between the users and the MTS network, especially as far as training and technical support is concerned. A lot of discussion is taking place about the skills and responsibilities of these local coordinators, and about their degree of involvement in pedagogical, content-oriented tasks, group animation, etc.

The technology providers include a technical support group, in charge of giving induction training and technical advice to the learners if no support is forthcoming from other local MTS partners. A group of experts on TV production also plays an important role in the project, because of the emphasis the system places on broadcast sessions.

Finally, evaluators are active throughout the whole process, compiling and distributing pre-, intermediate and post- questionnaires, holding in-depth interviews with as many actors as possible, and delivering regular reports to course and technology providers, in order to improve the system as courses progress and course and learner numbers increase.

- *Training settings*

Table 4.2 gives an analysis of the MTS training settings, showing the kinds of activities performed at each stage, the actors involved and the input/output interrelations.

The following settings have emerged from this analysis¹:

1. *Course Design* - designers from the course providers work together with technology experts to transform a traditional distance learning course into a set of telecommunications-based training materials to be developed and delivered throughout the network
2. *Marketing activities* - dissemination activities require communication among marketing experts from the different course providers and the MTS management team for learners' collection, on the one hand, and among the project partners for the promotion of the network and the further incorporation of courses, on the other. Marketing also requires the presentation of the project at meetings, seminars, etc. Successful action at this stage eventually leads to agreements with clients.
3. *Course enrolment* - the activities in this phase are the responsibility of each course provider, so there is no 'general MTS administration desk' at the moment. Consequently, the enrolment of students is a highly decentralized task that requires fluid communication between course and technology providers in order to coordinate their activities (the setting-up of user IDs for the system, contacts with the group coordinator to schedule DBS sessions, etc.)
4. *Course development* - this stage operates along three lines: CMC, TV programmes and other materials that might have arisen from the adaptation of the initial course to the network. In any case, the tutor from the course provider has to work closely with the corresponding specialist from the technology provider in order to produce the corresponding media, and he/she has to be ready to interact with learners during the course.

¹Data for the analysis of the training settings have been obtained from the following sources: the experience of the author as the coordinator of the Spanish partnership and project evaluation team, in-depth interviews with other members of the same team, MTS project documentation and user data collected by the evaluation team during the last two years.

5. Course Delivery - It is again the joint responsibility of the course provider and the local coordinator to make sure that the materials reach each of the learners, and to check that everything is ready before the start of the course. An induction session with learners is of crucial importance in creating positive attitudes in learners towards their performance on the course.

6. Course use - Three different sub-settings can be considered within this stage:

> *Asynchronous virtual classroom* - learners and tutors interact through a permanent contact point to have discussions, exchange ideas, assignments, corrections, etc.

> *Live virtual classroom* - a lot of actors are involved here, mainly learners who interact with content experts and receive feedback from tutors

> *Self-study* - a great deal of the course consists of personal homework in the form of assignments, with tutorial support.

7. Evaluation - As stated above, evaluation tasks and feedback require interaction between the assessment team and the ultimate users of the system (learners, tutors and local coordinators), in order to gather data, and with the interested MTS partners, for the communication of results and recommendations for further action.

8. Project management - Project partners are compelled by the Commission to meet at least once a year to review the progress of activities. Obviously, a continuous monitoring of project progress also takes place, requiring communication among the partners whenever a new idea or problem arises.

- **Telecommunication Scenarios**

The following telecommunication scenarios, shown in Table 4.3, have been extracted:

1. *Remote Meeting* - focusing on the pure exchange of ideas or briefings, it would consist of sending *text* messages through the network. This scenario would have to be consolidated as an important aspect of the management of the project, bearing in mind the distribution of partners stated above. It would be directed towards small groups *spread around Europe*, and it should allow for *asynchronous*, permanent communication. It may have pure conversational functionalities. As all partners are supposed to be involved in one way or another in this kind of scenario, it should also be technically *open to different types of networks and messaging standards*.
2. *Joint Authoring and Review / Course delivery (deferred)*- this scenario represents a higher level of complexity from the functional and technical points of view. The users should be capable of exchanging not just brief texts but also larger, formatted documents, for the purpose of creating and jointly modifying them. All the development tasks mentioned in the settings would have to be supported in this scenario, except for some parts of the TV production that have different requirements. As it is assumed that core materials have already been developed before entering the network, and the 'bridge materials' described above are textual (in the form of course guides) in order to minimize costs, the system should only support the *exchange of documents*. On the other hand, as the application is to be *asynchronous*, a file exchange function, or a facility for *file attachment* to the messaging service, would be appropriate as a support to the scenario. Conferencing, sending and retrieval functionalities are required.

<i>Scenario</i>	<i>Activities covered</i>	<i>Information requirements</i>	<i>Grouping</i>	<i>Coverage</i>	<i>Communicat. form</i>	<i>Synchronicity</i>	<i>Functionality</i>
<i>Remote meeting</i>	1.1, 2.1, 7.2, 8.2	Text - messages	Small group	European	Many-to-many, two-way	Asynchronous	Messaging or Conferencing
<i>Joint authoring and Reviews / Course Delivery (deferred)</i>	1.1, 2.1, 3.1, 3.2, 4.3, 6.1, 6.3, 7.1	Text-messages Text - documents, video	Small group	European	Many-to-many, two-way	Asynchronous, Synchronous	Conferencing, File exchange,
<i>Course Delivery (set materials)</i>	2.2, 5.1	printed materials, video, audio cassettes, questionnaires	Large group	European	One-to-many, one-way	Asynchronous	Large-scale delivery of different materials on request / dissemination
<i>Course Delivery (live)</i>	6.2	Audio, video, text	Large group	European	Many-to-many	Synchronous	Discussion, real-time questions & answers

Table 4.3
MTS System: Telecommunication Scenarios

This scenario covers the Asynchronous Virtual Classroom and Self Study settings, in which a permanent interaction point with a group of peers and a tutor, and the facility to exchange assignments and exercises form the core of the activities. Most of the administrative tasks (the distribution and reception of placement tests, the management of applications, etc.), can be supported in the same way.

3. *Course delivery (live)*- The *live* interaction of learners and tutors requires the definition of a different scenario, in which a more complex sort of information can be transmitted (*audio, video*), with an *ample coverage*, and with *two-way* communication facilities.

4.3.3. MTS System Requirements

The analysis of the organizational background, roles and settings has revealed several requirements, detailed below, that should be taken into account during the design of the system. These requirements are elaborated into recommendations for the design of the technical components as well as for building the adoption strategies, both making up the design of the architecture.

1. As already outlined, one of the distinctive characteristics of MTS is its commercial orientation. This requires the system to be accessible to as many user organizations as possible, in terms of the site infrastructure needed for workstations and network connections. The implication is that the system should be *available from the most widespread telecommunication networks*, and that *site equipment* should be unsophisticated, in order to facilitate adaptation to simple site configurations.
2. The description of roles performed during the first stage of the analysis has revealed that, at this early stage, the learners cannot be identified, until a

specific UO shows interest in the project. Consequently, a related requirement is that the system be open in terms of the type of potential UO users, in so far as organizational influences and individual skills and conditions are concerned. Adoption Strategies, therefore, should take into account that *novice users can catch up with more skilled users* so as to eventually make up uniform groups of learners.

3. the international character of the project, with providers and UOs ideally coming from different countries, means that the *network should be as decentralized* as possible, in order to prevent large connection costs. This can also create language problems, so that *iconic and even multi-language user interfaces* should be used.
4. One of the most important aims of the project, as stated in the original project description (MTS, 1992) is to **augment interactivity** possibilities for distant learners. For this purpose, *both real-time and asynchronous technologies* should be combined, with a view to providing the user with as many interaction situations as possible.
5. In the case of language teaching, the subject of most of the courses, the **practice of oral skills** is a must, and therefore requires the system to provide *integrated (at least audio) real-time communication facilities* in some parts of the courses.
6. The **innovative character of the project** (shown by advanced R&D) means that the UOs have a very low level of awareness of ways to cope with this kind of system. This has important implications for the design of the Adoption Strategies as well, mainly addressing *information to the UO at different levels*. It also implies that *key UO roles have to be modelled*, with their own features and tasks in the system, and largely depending on their organizational context.
7. The use of technologies contemplated in MTS involves setting up learner sites. If the installation of infrastructure in the UOs **requires expenditures**, *the benefits of making the investment will have to be made evident to the organization*. The ADAM approach states that in order to study the opportunities that the system can bring to the organization, an analysis of the context has to be made,

and fluid contact with those holding the key to implementation has to be established.

8. Finally, the de-centralized character of the project means that fluid communication among partners is essential for efficiency. This means that for MTS to operate smoothly (especially, if it is open to inputs from an increasing number of course providers as well as UOs), *every partner should use the network for every activity of the project*, and not only for the pedagogical exploitation of the technology. Again, this requirement has to be met by giving proper training in the use of the network, addressing all the potential actors involved.

4.3.4. The Model Defined by ADAM

The user-centred and context-dependent philosophy underlying the ADAM approach reveal one aspect of MTS that merits some reflection at this moment: the existence of two different kinds of users. The roles of designers, providers, teachers, etc., in the system have been amply described, but what about the people and activities in the organization receiving the courses? They clearly have to be analyzed from a different perspective. The definition of the MTS TST system's boundaries, if we use the ADAM approach, requires two distinct sub-systems, each with its own contextual conditions and goals: the MTS project subsystem, and the potential UO subsystem.

Firstly, there is the MTS project subsystem, in which courses are adapted, marketed and operated, with the whole process being evaluated and managed. The contextual conditions in which the project was developed (the main ones having been described in the introduction) influence the definition of activities as well as the users who participate in the various activities in the system. The introduction of telecommunications support and its subsequent acceptance on the part of users will improve the quality of the courses on offer, as well as the investments made by the project partners. These improvements will undoubtedly

affect the organizational conditions of the project (e.g., the condition of 'research project' may well turn into 'commercial venture', and later into a 'successful company', resulting in modifications in the partnership structure, etc.)

Let's now consider the same factors for the potential UO subsystem. The background is clearly expected different from that of the MTS project, mainly large corporations with professional updating needs and infrastructure for coping with innovations in their training processes. As for the roles involved, by being a different subsystem, it is not only the learners who participate, but a set of key people have to be defined, if the system is to gain acceptance on the part of the UO: the ADAM approach has suggested that at least one person from the area of training and one from the technical side have to be involved in the process (A 1.2.5.: 'Identify project team'). Together with the local coordinator of the implementation, they play key roles in the enrolment, installation and course operation processes. If the use of technologies as a support to these processes gains acceptance on the part of the users, it will result in an improvement to some parts of the company training system, eventually leading to larger contracts with MTS and ultimately to the consequent changes in the organizational structure.

As we can see, the design of the MTS model in the light of the ADAM framework results in a definition of two subsystems, each requiring tailored adoption strategies. As far as the technical components are concerned, the UO settings have effectively been included in the MTS analysis of telecommunication scenarios (under the headings "course delivery" and "course use"), and therefore the selection of services has been made on an integrated basis for both subsystems.

As a result of this analysis, Figure 4.2 shows the model which has emerged through ADAM. It can be compared with the actual MTS model, presented in Figure 4.3. Noticeably, two clearly distinguishable subsystems fall within the system's boundaries: the context of people and activities in charge of the

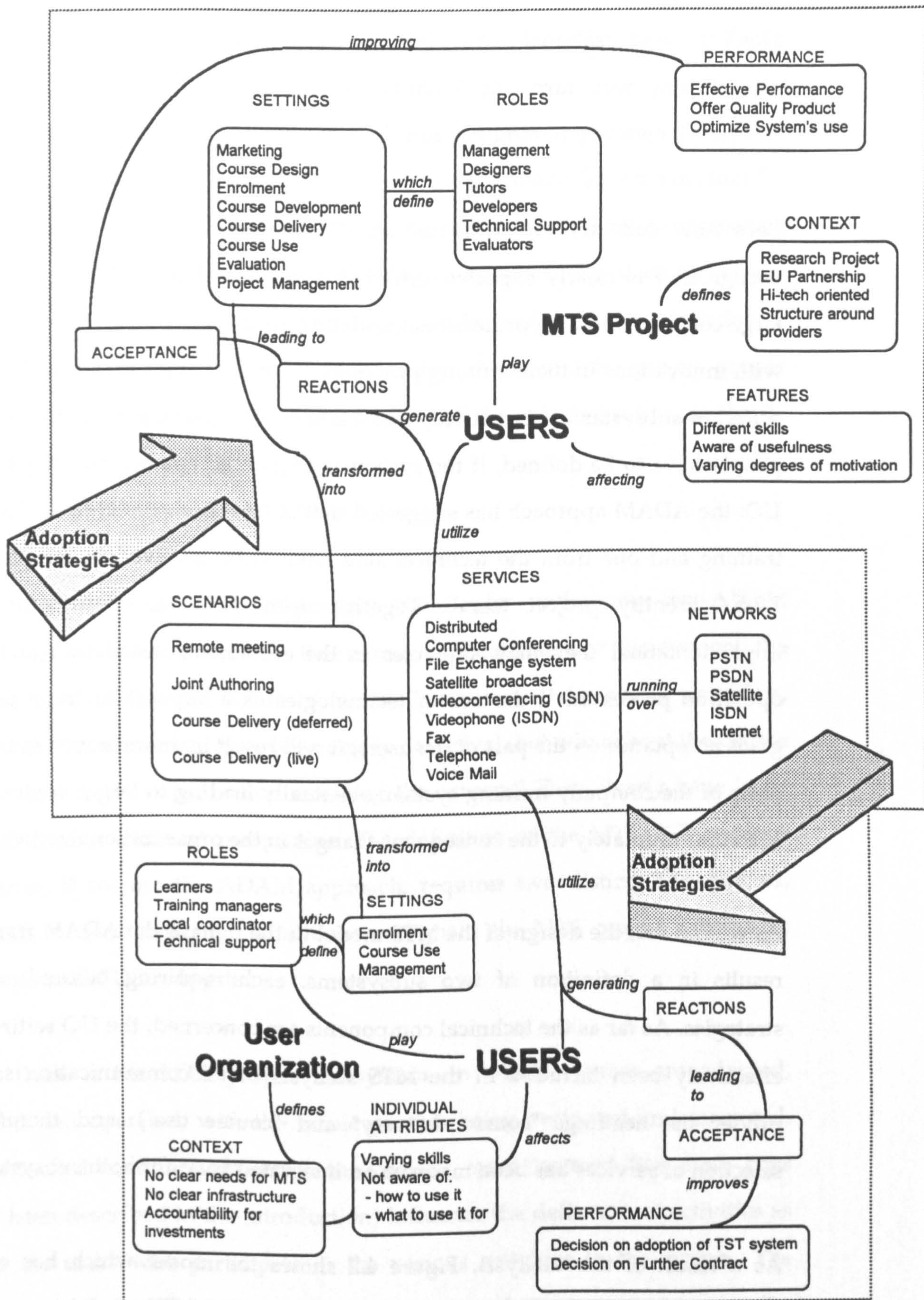


Figure 4.2. TST Model defined by the ADAM Approach for MTS

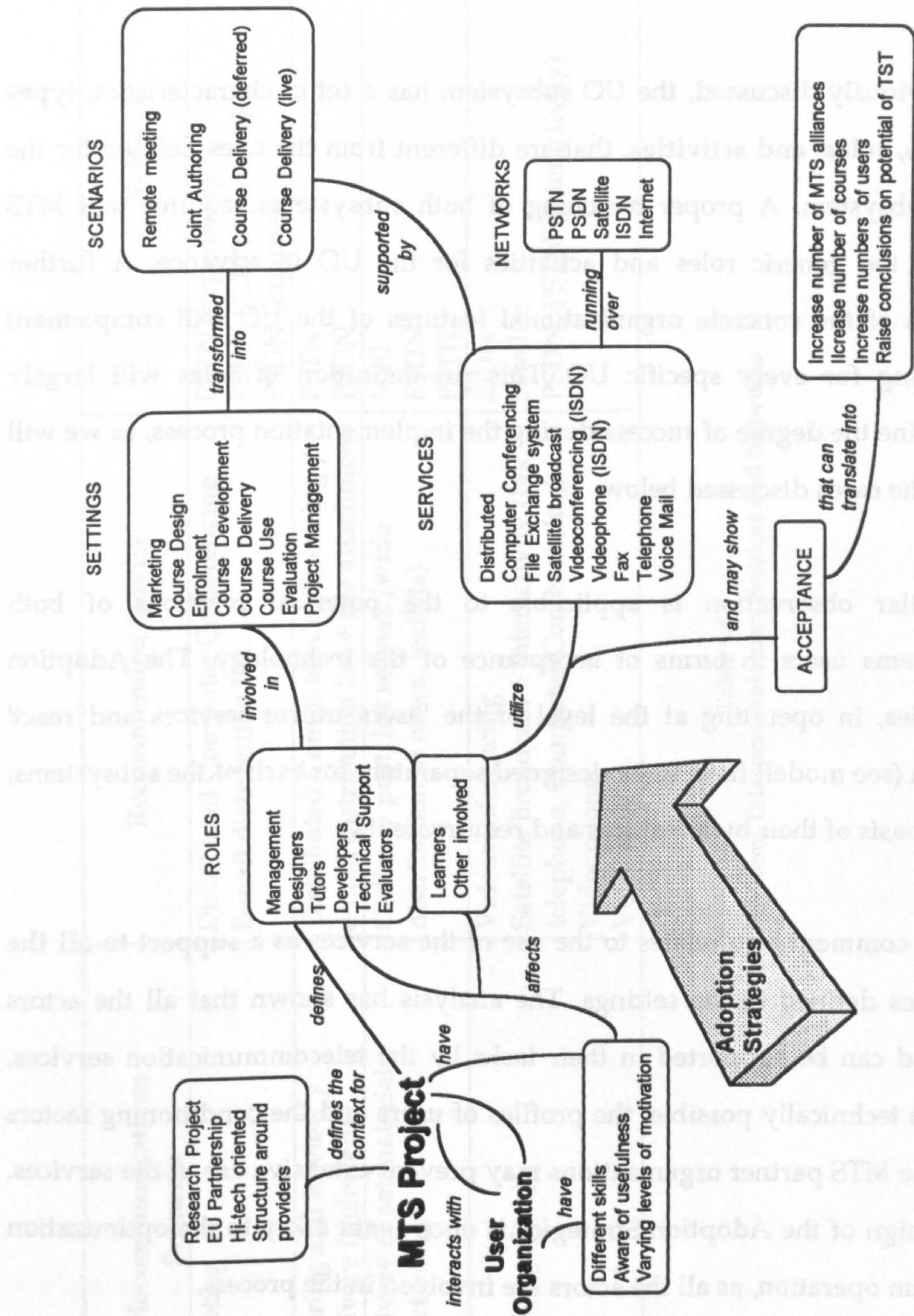


Figure 4.3.. TST System designed by the MTS Project

production aspects of MTS courseware, and the context corresponding to the user organization (UO) which is to receive MTS courses. Both systems are linked through the use of the telecommunications services accessible via different networks. The importance of this distinction is expressed in the following points:

- As previously discussed, the UO subsystem has a set of characteristics, types of users, roles, and activities, that are different from the ones defined for the MTS subsystem. A proper matching of both subsystems requires that MTS defines the generic roles and activities for the UO in advance. A further analysis of the concrete organizational features of the UO will complement modelling for every specific UO. This pre-definition of roles will largely determine the degree of success during the implementation process, as we will see in the cases discussed below.
- A similar observation is applicable to the potential reactions of both subsystems users in terms of acceptance of the technology. The Adoption Strategies, in operating at the level of the 'users utilize services and react' relation (see model) have to be designed separately for each of the subsystems, on the basis of their own features and requirements.
- A final comment also relates to the use of the services as a support to all the activities defined in the settings. The analysis has shown that all the actors involved can be supported in their tasks by the telecommunication services. Though technically possible, the profiles of users and the conditioning factors from the MTS partner organizations may prevent extensive use of the services. The design of the Adoption Strategies is once again a key to the optimization of system operation, as all the actors are involved in the process.

The model could even be expanded by defining a third subsystem, that of the potential course providers who may be willing to input their courses and offer

Telecommunications Scenario	Recommended Service	Network
Remote meeting	Distributed Computer Conferencing E-mail distribution list	PSTN (expensive) PSDN (X.25 expensive) PSDN (Internet)
Joint Authoring and Review / Course Delivery (deferred)	Distributed Computer Conferencing / e-mail distribution list + file attachment	PSTN PSDN
Course Delivery of set materials/ Diffusion activities	Ordinary post, list servers (wide distribution of news, leaflets)	Mail PSDN PSTN
Course Delivery (live)	Videoconferencing Satellite Broadcast + Interactivity (fax, telephone, Computer Conferencing) Videophone Voice mail	ISDN Satellite PSDN, PSTN (interactivity)

Table 4.4
MTS System: Telecommunication Services and Networks

them over the network. This subsystem would require the same design treatment as that given to the UO one, taking into account specific characteristics and the pattern of integration into the whole TST system. This inclusion has not been made, since the number of course providers has been quite steady throughout the project; but the observation shows how the approach allows for alternative conceptions of systems, according to the designer's criteria regarding the boundaries of the system (contained in the initial overall context analysis).

4.3.4. Architecture defined by ADAM

- **Technical Components**

Table 4.4 shows the telecommunications services that best fit the scenarios stated above, together with the minimum network requirements. It could be claimed that the system is supported mainly by a group messaging system, with integrated file transfer facilities, and that the satellite transmission will deal with the real-time broadcast communication. As for the interactivity in this case, the network is supplemented by other media, such as e-mail, fax and telephone.

This design solution, recommended by ADAM, is practically identical to the one adopted by MTS, except for the inclusion of the Internet network (suggested in order to increase access to the system as much as possible), the suggestion to select a distributed system for messaging and conferencing, and the voice mail service (which has also been put forward by MTS, though not actually used).

The technical architectural components as designed by the ADAM approach and as presented by MTS are shown in Figures 4.4-4.5, respectively.

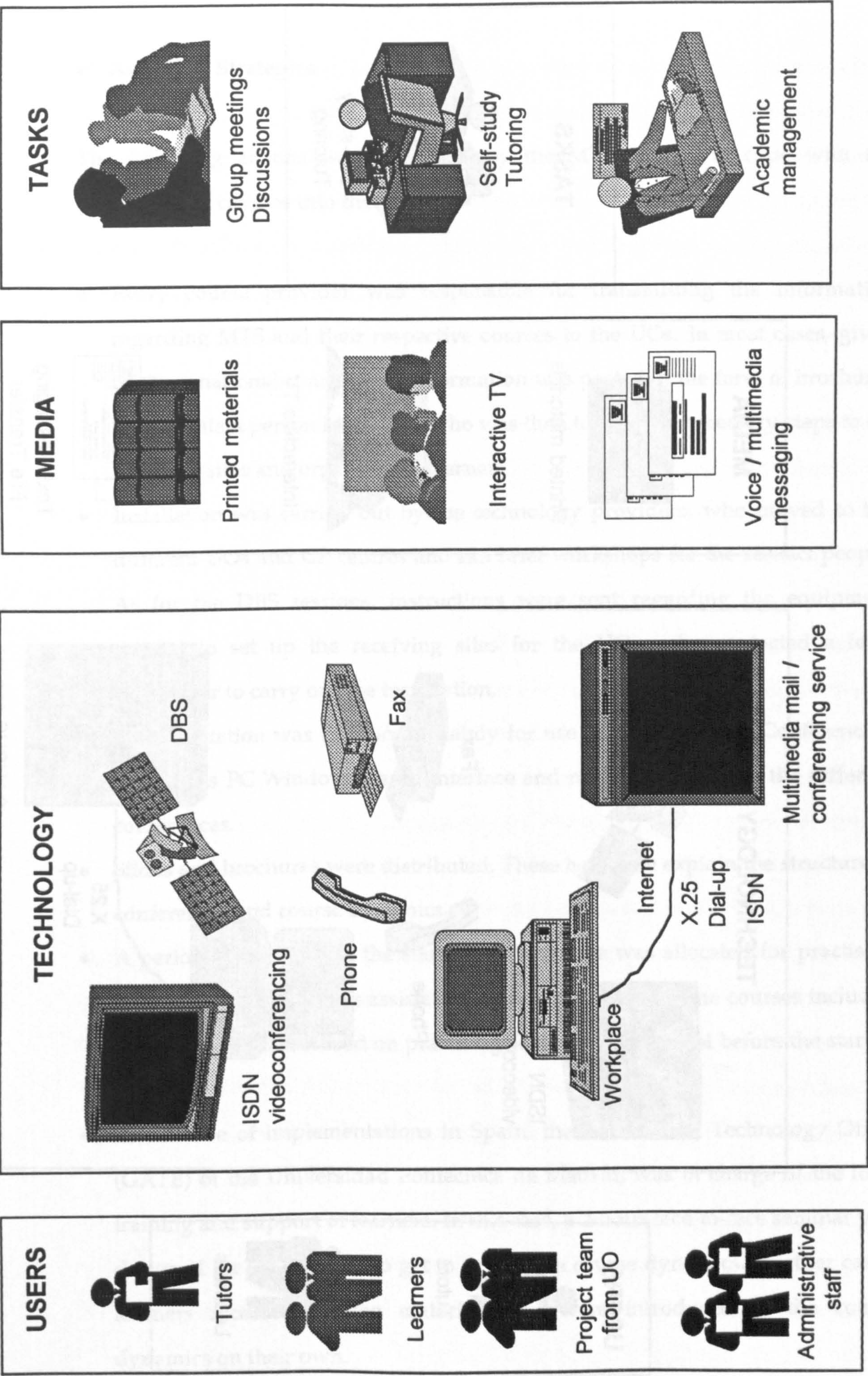


Figure 4.4. Architecture defined by the ADAM Framework for the MTS system

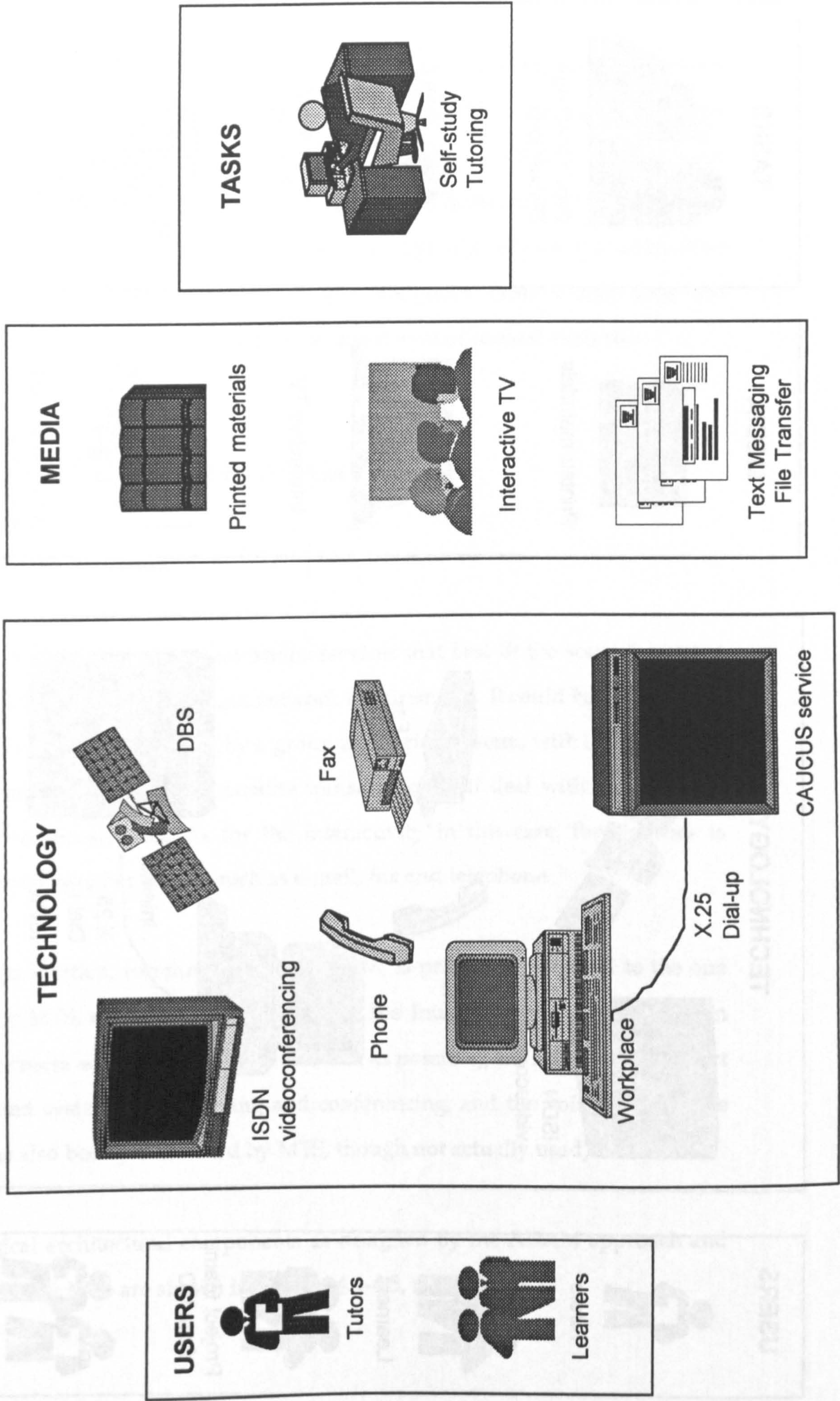


Figure 4.5. Architecture defined by the MTS project

- **Adoption Strategies**

The following actions were designed by the MTS system to cope with the integration of courses into the UOs:

- Every course provider was responsible for transmitting the information regarding MTS and their respective courses to the UOs. In most cases, given the transnational context, this information was posted in the form of brochures to the contact person in the UO, who was then to take the necessary steps to set up of the sites and organize the learners.
- Installation was carried out by the technology providers, who moved to the different UOs and CP centres and ran brief workshops for the contact people. As for the DBS sessions, instructions were sent regarding the equipment needed to set up the receiving sites for the UOs, who contacted a local distributor to carry out the installation.
- Documentation was produced, mainly for use in the Computer Conferencing system, its PC Windows-based interface and navigation through the different conferences.
- Slides and brochures were distributed. These helped to explain the structure of conferences and course dynamics.
- A period of time before the start of every course was allocated for practising with the system with the assistance of an on-line tutor. Some courses included an initial module focused on practising with the on-line tool before the start of the course.
- In the case of implementations in Spain, the Educational Technology Office (GATE) of the Universidad Politécnica de Madrid, was in charge of the local training and support of learners. In this case, a 2-hour face-to-face seminar was designed for the learners to get to grips with course dynamics. In other cases, learners received written materials and were introduced to the course dynamics on their own.

- Problems and questions regarding pedagogical matters, such as course dynamics, assignments, use of the self-study conferences, etc., were the responsibility of the course providers. Tutors would monitor learners' performances so that the course ran smoothly.
- Support regarding technical issues, such as connections to the system, the downloading of materials, sending assignments, and navigation through the system was channelled via the contact person in the company to the course provider, who redirected it to the technology provider if appropriate.

Let's now compare both models in Figures 4.2-4.3 again. They show that each subsystem required its own design of adoption strategies, starting from its own contextual factors. For example, the users in the MTS project subsystem are aware of the 'what for' in using the system, though not necessarily of the 'how'. In turn, the users of the UO are possibly unaware of both the usability and usefulness aspects of the system, therefore requiring a design of strategies at different levels.

The adoption strategies recommended by ADAM, in consequence, differ from the ones designed by MTS in the following aspects:

- The level of initial awareness and information has to be carefully considered (A 3.3.1: "Design information strategies"), since it will determine the overall attitude of the UO towards MTS courses. The benefits that every organization may get from their participation in the project should be addressed, in order to justify the investments to be made. Moreover, the information level of adoption strategies has been defined within the ADAM approach as addressing every actor in the OU subsystem, not only the learners.
- Training strategies have to be designed in a modular way, so that they can be customized to the skills of learners in terms of the use of the technologies. The materials should ideally be developed in the learners' own language, unless the group is certainly fluent enough in English.

- In order to meet the objective of interactivity stated by the project, not only must technologies be made available, but animation strategies fostering participation must also be implemented, either by tutors and/or by local coordinators, if such a role exists in the organization. As stated by the approach, both the navigation methods (the "how") and the conceptual metaphors underlying the technologies (the 'what for') have to be transmitted, if user acceptance is to be gained (A 3.3.3.: 'Design user training strategies').
- One of the requirements pointed to the need for all the actors, not only tutors and learners, to use the system as a support to their own tasks. Activities have to be designed along these lines, with strategies ranging from requesting commitment from course providers at management levels to operating basic training programmes within every organization (A 3.3.2.: 'Design user induction strategies').

4. 4. Implementation of MTS in UOs

The sections presented so far have shown that the analysis of an existing system performed with the ADAM approach gives rise to alternative design solutions that may lead to improvements in some aspects. The results of the implementation of MTS in two different organizations will now be presented with the aim of providing experimental evidence of UO, reaction concerning the organization of the courses and acceptance of the technology utilized.

During Phase I, the 'English for Banking' course was developed and implemented at a large bank in Spain. The results show some of the system's weak points (Simón, 1994a), and how the alternative design proposed using ADAM as an analysis tool would have coped with them.

Conversely, during Phase II, a new set of courses were run and modifications were introduced into the system, following the recommendations of the evaluation team and taking into account the 'lessons learned' so far. From the second group of UOs, a large German organization, DB Telekom, has been selected since it has shown a great deal of success in implementing the "English for Telecommunications" course at different sites with a large number of learners. Several factors arise from this case that serve to reinforce some of the aspects made apparent by the analysis, thus showing the suitability of the approach in revealing critical design factors in TST systems.

As a detailed discussion of both cases would fall beyond the scope of this section, the most significant results have been selected from the evaluation carried out by the team at MTS (WIK, 1992; Fries and Simón, 1993; Simón, 1993; WIK, 1994).

UO1: A large Spanish Bank

The User Organization (UO) is one of the largest banks in Spain, employing nearly 20,000 people all over the country. As part of the company strategic plan stated by its top management, the objective of the Corporate Development department was to enter the field of technology in order to reach personnel scattered around small villages far from the big training centres in a more cost-effective way. The institutional objective, then, was to carry out an internal test of the MTS system and study its suitability and possible adaptation to the bank's needs.

With this aim in mind, the corporation made a commitment during the initial negotiations to enrol 25 learners for the 'English for Banking' course. When courses commenced, this number had dropped to 4 learners. The causes for this change of decision, as reported by the organization (GATE Intermediate Evaluation Report, 1993) were:

- The information received about the course requirements had been insufficient. Moreover, this information had been filtered down from the corporate development managers who had held the negotiations, so that it was not properly transmitted to the technical staff.

Thus, the condition from MTS was that an antenna for reception, an X.25 network and modems for the learners had to be available. As the answer to this was affirmative, a low budget was allocated for purchasing infrastructure for the project. When the MTS support team approached the company to set up the equipment, it was found that the Computing Department had not been previously consulted about the use of the PSDN network. When they were consulted, their answer was that permission to open it would be refused for security reasons. Besides, the modems available were synchronous and therefore unsuited to MTS purposes. Finally, the antenna existed and was certainly powerful enough, but it was located at a large training centre 30 kilometres from the city, which prevented regular use by learners.

This example shows the importance of analyzing all the actors who have to intervene on behalf of the UO during the modelling process. A combination of the organization lacking awareness of the project, and not involving the right people in advance, can cause misunderstandings and reluctance, seriously hindering the development of the project.

It also reveals the barriers to accessibility, previously stated as an ADAM design requirement. MTS was conceived as a system that should work with "stable technologies", but the conception of what actually constitutes a well-established service in an organization is still very different from the estimate of this R&D project (WIK, 1994).

- The lack of proper infrastructure meant that the selection of users was finally made on the basis of the availability of equipment, instead of giving priority to their skills and need to be trained in the course contents.

The problem of "artificial learners" running the experiences has been a matter of considerable discussion throughout the project (Sippel, 1993). In this particular case, in which the company is interested in experimenting with the use of these technologies in a specific context, the sudden change of learners made it difficult to draw conclusions about future actions to be taken.

- Regarding the cost of the course, the UO was given a substantial discount, from the course fee. The UO had to meet the cost of connection to the Computer Conferencing system as well. Table 4.5 shows an estimation of the cost per student for this case study.

The cost of the course was regarded as high by the UO. Uncertainty about the final cost together with the need to contract a dial-up service to the X.25 network contributed to scepticism in the estimation of cost-effectiveness. Finally, problems (mainly technical) arising at several stages of the experience were severely criticized, as if the course were an established commercial product. A possible reason for this attitude could be that the UO had not been made aware of the potential benefits to be obtained from this investment. Equally, management is reluctant to allocate a budget to an infrastructure if they are unsure about its future uses.

<i>X.25 Connection Variable Costs:</i>		
Average cost for X.25 connection per minute		0,28 ECU
Total connection time		5,390 min.
<i>Total variable costs</i>		<i>1,509.2 ECU</i>
<i>X.25 connection Fixed Costs:</i>		
X.25 Initial Subscription		265.6 ECU
X.25 Monthly Rates		275.2 ECU
No. of months		8
<i>Total fixed costs</i>		<i>2,467 ECU</i>
Total X.25 connection costs		3.976,4 ECU
No. of learners		4
<i>X.25 connection cost per learner</i>		<i>994 ECU</i>

Course fee per learner		500 ECU
Infrastructure per learner:		
Modem (for dial-up connection)		190 ECU

Total course cost per learner		1,684 ECU

Table 4.5. An example of estimated cost per learner - "English for Banking" Course (1993)

Acceptance and Use of the System

The course was very well received by individual learners. In the evaluation, they referred to the interest of the contents, the quality of the materials, and the attention received from the MTS support team and the course tutors. However, none of them managed to finish the course; out of six assignments due, one learner submitted five and the rest did not reach the third. The reported reasons reported for the bad performance were (GATE Intermediate report, 1993):

- limited opportunity to study at work because of the workload,
- lack of acquaintance with the use of a telematic system for self-study, in spite of their previous experience with computers, thus hindering participation, and

- lack of experience in distance learning, which prevented self-discipline and organization.

It is remarkable that the learners' experience with the DBS component was highly successful, in contrast to the computer conferencing service. Despite dropping out of the course assignments, and the unsuitability of the timetable (sessions were run at European lunch time, which is 3 hours before the Spanish one), the four learners attended practically all the sessions, and enthusiastically participated in the activities proposed in the programmes. Other face-to-face activities, such as the induction sessions organized by GATE as MTS local support were also warmly welcomed.

Regarding the technical support they had received, learners said they felt quite comfortable with a contact person who spoke their language and with whom they could interact freely. The need for support was so pressing that, in spite of the hotline available at any time, the local coordinators decided to spend some time after every DBS session in solving technical and pedagogical problems. This extra service was also greatly appreciated by the users.

UO2: DB Telekom (Germany)²

DB Telekom participated in Phase I of MTS with 80 learners and increased the number to 160 during Phase II. The organization has closely collaborated with MTS management in evaluating the first stage, and searching for critical factors in the use of the system. The implementation is currently a success, and the main factors reported by the UO are the following (Dremeau and Elz, 1994; WIK, 1994):

² Data for this UO has been selected from reports and papers published by MTS participants. The author has not been directly involved in this implementation and therefore references to the corresponding publications are made whenever necessary.

- The company has realized the need to invest its own resources to support the experience internally, if courses are to run smoothly. A UO coordinator is responsible for the organization of the courses. His job is to contact every potential user directly and provide the information personally, in addition to running the technical support.
- The problem of 'artificial learners' also emerged in DBT, being estimated as one of the major causes of the high drop-out rate. As for Phase II, the UO has carefully analyzed which type of learner is addressing MTS in context. They have found that this profile corresponds to someone with a strong need to become skilled in course contents, and who cannot travel to the resource centre within a fixed timetable in order to receive classes. In this sense, they have searched for criteria of usefulness and have made learners aware of the benefits they can enjoy by using the MTS system. This has been resulted in a much higher level of enthusiastic participation by the users.
- The UO has also realized the need to allocate resources for local pedagogical support staff, who learners can contact in their own language if they encounter problems, either with the technology or with the courses themselves. The UO coordinator also organizes group tutorials throughout the course. This service increases motivation and guides learners whenever they have difficulties in self-learning.
- During Phase I, learners were directly contacted by the training management through a formal letter. This caused negative reactions from line managers, the consequences being a reduction of the work time allowed for self-study and the creation of an uncomfortable atmosphere for training activities. In Phase II, a multi-channelled information method was followed, and the letters were replaced by more informal conversations not only with every learner but also with others less directly involved in the programme.

- Operating a complete installation process in every workplace would have been too expensive for the company. In order to reduce infrastructure costs, the concept of MTS had to change from being workplace-oriented to site-oriented, mainly due to the DBS component and the lack of user connections to the X.25 networks from their computers. Along the same lines, the problem of accessibility meant that only those candidates working close to the training centres were eligible to participate in the course. This situation was deemed to go against the theoretical flexibility of the MTS concept, as well as against the organizational need for distributed training.
- These access problems, which affected every UO taking part in the project, brought about a reduction in the technological demand for the implementation of courses. Thus, for example, ISDN experiments, initially intended to run on learners' computers, were left for the DBS sessions. In spite of this reduction, the implementation of the lowest configurations in DBP involved expenditure, which was considered sensible because plans provided for the continuation of TST training in other areas.

4.5. Conclusions

Some of the most significant conclusions arising from the exercise of using the ADAM approach as a tool for analyzing the MTS TST system are stated below. Some research results are also discussed in that they may contribute to expand knowledge on the field.

1. The ADAM approach has been shown to be capable of analyzing a system already in existence, producing an alternative design from which discussion and recommendations result. A model of the MTS TST system (see Figure 4.2) has

been produced by following the specific modelling technique described in Chapter 3, and defining the system's boundaries, elements and interrelations.

2. The resulting model has implications for the architectural conception of MTS, both in terms of the telecommunication components and the adoption strategies. Interestingly, the technical design resulting from the analysis is practically identical to the actual one implemented by MTS. In fact, it is in those aspects concerning organizational and human factors where the two models differ. This can be interpreted as an evidence of the technology-driven character of TST systems, a constant theme in this work, not only in relation to the training milieu (Reeves, 1993), but also to the well-established Information Systems field (Avgerou and Cornford, 1993).

3. Evidence from the implementation of MTS in two different UOs has shown the importance of adoption aspects for the success of the project in terms of acceptance, not only by the learners but also by other relevant members of the organization. For its part, it is also noticeable that these aspects have in many cases been identified in the analysis by following the recommendations for Context and System analysis in stages 1 and 2 of the ADAM approach. In this sense, ADAM can be considered a good 'explorer' of non-technical risk factors, also providing recommendations to cope with them as adoption strategies (Stage 3, Step 3.3), in order to achieve the proper balance and interaction of both architectural components.

4. The factors pointed out during the experiences as critical have been detected by the approach at different stages of the analysis. However, the results show that the effective implementation of a TST system brings about substantial changes in the organization where it is introduced, which are more dramatic than the model reflects. In this sense, the increasingly successful DBT case shows how the training area is undergoing what Conley (1993) would call a 'reform' (changes in

procedures and rules) in its activities, and in some areas it is even embarking on 're-structuring' (changes in fundamental assumptions, practices and relationships). The creation of new roles, the modifications made to the communications strategy, switching to a more widespread information strategy, and the decision to incorporate other types of TST products in training processes are all good examples DBT adoption indicators.

It could be argued, on the basis of the data, that the consequent resulting model would have to give the UO subsystem even more importance than it currently has (see Figure 4.3). This conclusion would imply:

- placing the design emphasis on the target organization, rather than on the provider of the service,
- reinforcing ADAM assumptions about the importance of contextual and human aspects in comparison with technical components, and
- stressing the need to dilute the technological character of the design more in favour of a 'softer' perspective.

This conclusion is more applicable to non-tailored commercial systems such as MTS, in which the subsystem of the provider and that of the UO are substantially different. By contrast, the conception of TST systems developed within the same organization on a customized basis poses a different set of interrelations among the actors. This warrants another type of discussion, being a matter for further investigation.

5. The conditions reported by the users as critical for success, and which previously have been identified by the approach were found to be:

- the careful consideration of every role involved in the system in a more or less direct sense throughout the different stages of the design and implementation process,

- increased awareness of the project on the part of the actors, with a view to their involvement,
- a realistic assessment of actual current state of the technology in the organization
- customized induction and training, not only in relation to the use of the technologies themselves but also regarding good practice in the general context.

6. Limited technology accessibility has revealed as the most important constraint concerning technological components. Its consequences have been seen to affect not only individual acceptance, by inhibiting participation, but also organizational adoption, by subjecting the selection of learners to factors other than the attainment of institutional goals. This once again demonstrates the technology-driven character of the projects. Learners had to travel to a centre far from their workplaces at inconvenient times in order to follow the DBS sessions, making training much less flexible than they would have expected. However, it is noticeable that the degree of satisfaction with this technology was higher than was the case with the asynchronous tool. The power of real-time, face-to-face-type technologies seems to convey a more direct perception of both usability and usefulness, directly affecting acceptance and the use of the services.

7. Organizational attitudes towards investment concerning the implementation of a TST system such as MTS have been shown to be justified only in the context of a long-term use of technological support. This idea reinforces the trend appearing in the development of Information Systems, in which there is a shifting paradigm from 'IS development' to 'IT strategy'. Along these lines, it would not be unrealistic to anticipate that, in the long term, TST systems will form just one part of such an IT strategy, in which (as the ADAM approach states) every actor in every activity is intended to be technologically supported.

8. Finally, as a result of the data and discussion held in this section, it can be stated that the following factors would have been analyzed, designed and implemented in a different way if the ADAM approach would have been used in the context of the Multimedia TeleSchool project:

- A larger, more detailed analysis of the actual and realistic conditions of the User Organizations would have been made, with the corresponding set of recommendations arising.
- A project team would have been created, combining relevant people from several sectors of the UO and MTS technical and management representatives. This would have brought a larger degree of involvement and information of all the actors playing a role in the project.
- The designed architecture would have included, together with the same technological components, a greater number of adoption strategies, specially information and induction ones, and addressing a larger audience in the UO.
- The accessibility to the technology would have been increased, mainly in terms of types of networks logging into the Computer Conferencing server.
- The benefits of participating in the project would have been made more explicit from the very beginning to the UO management and project team, in order to increase the motivation of the actors towards the MTS system.

9. An observation concerning the users of ADAM should also be included in this section. In the author's personal experience of the application of this approach, the analysis process is considered a highly creative one, with ADAM actually being used in a very flexible way. Its use by someone without TST experience may

require the development of instruments (checklists, interview scripts, etc.)
providing more explicit guidelines for carrying out the process.

Chapter 5:

ADAM as a Design Tool:

A TST in operation at the Universidad Politécnica de Madrid

5.1. Introduction

5.2. Application of the ADAM Approach

5.2.1. Stage 1: Context Analysis

5.2.2. Stage 2: TST System Analysis

5.2.3. Stage 3: TST System Design

5.2.4. Stage 4: TST System Implementation

5.2.5. Stage 5: System Maintenance

5.3. Conclusions: Considerations Regarding ADAM

5.1. Introduction

The present case study will show the power of the ADAM approach to design a TST system. This work has been developed under the Telematics Programme (TelEd) run by the Educational Technology Office (GATE) at the Universidad Politécnica de Madrid (UPM).

The Educational Telematics Programme (TelEd) had as its main aim the introduction of Telecommunications technologies as a support to the faculty in the different academic settings at the UPM. The activities carried out within this programme, under the coordination of the author of this thesis (Simón, 1994b;

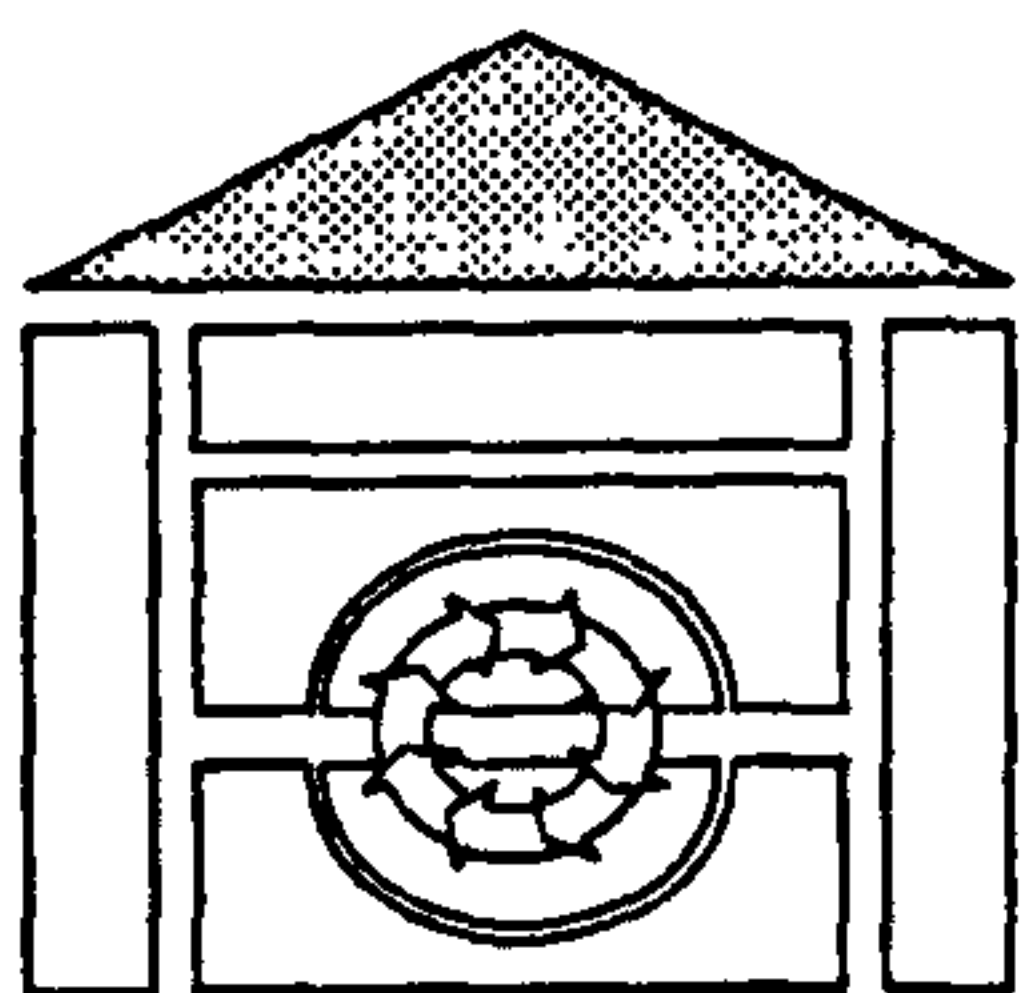
Simón and Martín, 1994), have set the experimental basis for testing the methodological approach presented in the work .

The following issues are the central points to be discussed in the light of this case study:

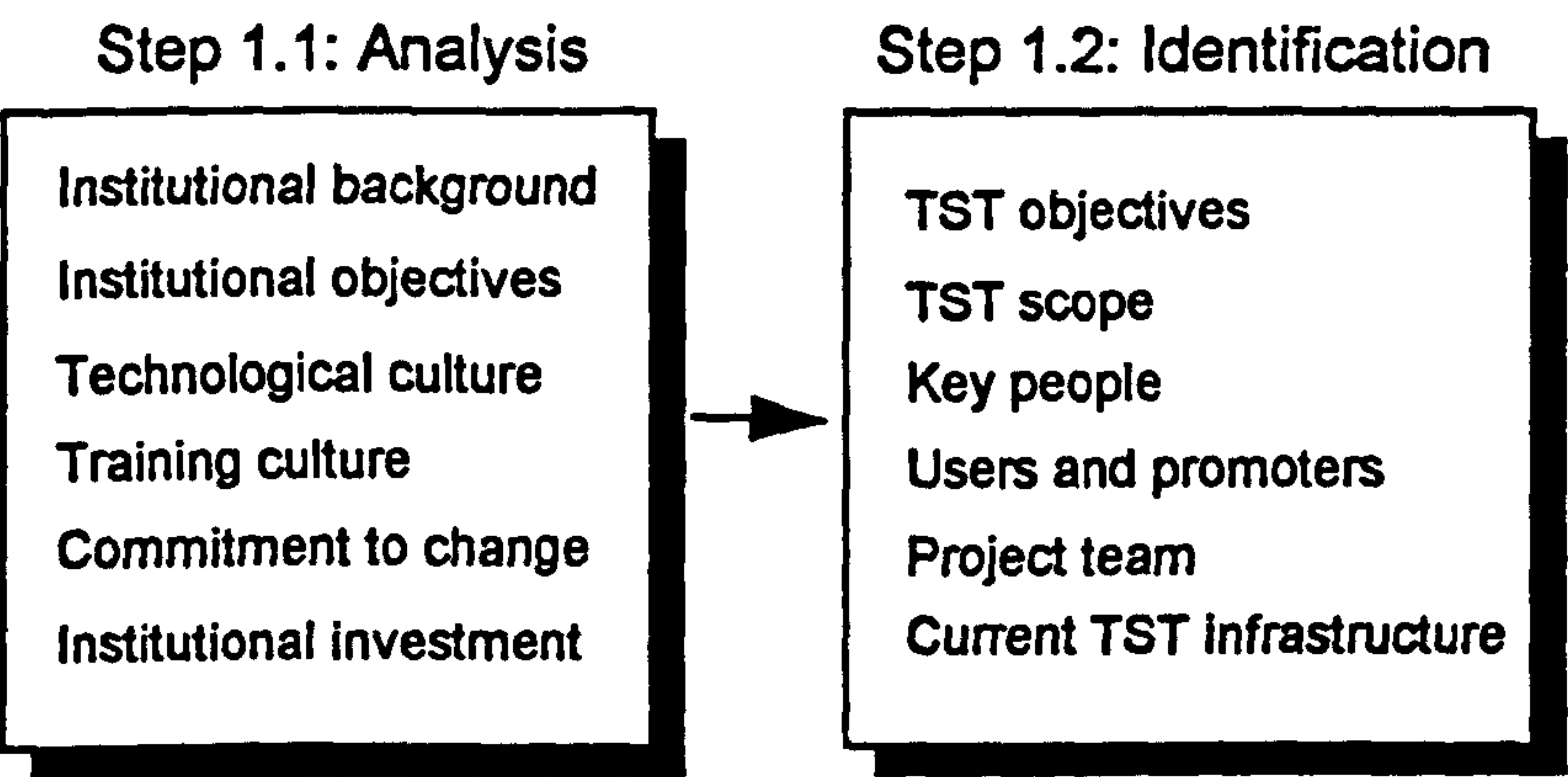
- The high degree of complexity resulting from the environment and conditions in which the TelEd team had to work required adopting (i) a comprehensive view and (ii) a systematic approach to the problem of promoting the use of telecommunications in the UPM as a support to academic activities. The study will show those factors that, if overlooked, would have had very negative consequences during the course of the programme.
- The application of ADAM in this case will prove the importance of approaching the architectural design process by:
 - starting from the careful analysis of users' activities and further categorizing them into technological parameters leading to Telecommunications services, and
 - filtering the different architectural alternatives through requirements and constraints previously inferred from the context analysis
- The types of roles required for setting up activities properly, and their influence in the results of the experiences will also be made evident
- The case will equally show the balance between technical and non technical factors and their combination in the proposal of a TST architecture

The following sections will describe the actions performed at the UPM, discussing how the approach was followed, and the results and consequences of its use.

5.2. Application of the ADAM Framework



5.2.1. Stage 1 - Context Analysis



Step 1.1 - Analysis

- *Institutional background (A1.1.1)*

History and structure

The Universidad Politécnica de Madrid (UPM) is the largest of the technical Universities in Spain, with around 50,000 students, 5,000 teachers, and a staff of 800 administrative and support staff. Its tuition field covers practically all types of

Technology and Engineering, Architecture and Computer Sciences. Courses within this University comprise both 3-year technical Diplomas (the so-called Technical Schools) and longer, 6-year courses leading to a degree in Engineering. The University as such was founded in 1971, but by that date many of the Schools had already been in existence for a long time.

Engineering Schools offering 6-year courses	Technical Engineering Schools offering 3-year courses
Telecommunications Engineering	Telecommunications Engineering
Industrial Engineering	Industrial Engineering
Forestry Engineering	Forestry Engineering
Agricultural Engineering	Agricultural Engineering
Aeronautic Engineering	Aeronautic Engineering
Civil Engineering	Civil Engineering
Architecture	Architecture
Computer Science	Computer Science
Mining Engineering	Topography
Naval Engineering	

Table 5.1 The 19 Schools in the UPM

The UPM was then created with a view to grouping together and coordinating what at that time was a set of powerful, highly autonomous Engineering Schools, closely linked to their corresponding Professional Colleges and each with their own, well-established procedures. The University is currently comprised of 9 Engineering Schools, 1 Computer Science Faculty and 9 Technical Engineering Schools, spread over the city of Madrid and the surrounding area, some of them located in the centre and the rest concentrated in two separate campuses.

History and traditions, therefore, vary widely in the different Schools, and one could claim that the degree of cohesion among them is more a matter of political understanding than a real university corporate spirit. The relevance of this fact for the purposes of this case study lies in the great diversity shown by the University if it is analyzed with a holistic view in an attempt to implement any sort of common system or activity.

Figure 5.1 shows the UPM structure.

The creation of the Educational Technology Office (GATE)

In 1991, the Rector of the University created the first Educational Technology Office in the country. The Office, whose acronym in Spanish is GATE, was conceived as a service to all the University faculty, acting as an "observatory" for new technology applications currently underway in the Engineering teaching field that might serve teachers in any of their academic duties.

The main objectives stated by the Rectory regarding GATE's mission were to:

- promote the use of technologies within the University faculty as a support to academic activities,
- act as an Observatory of technological applications in Higher Education, mainly through setting up relevant contacts in the field, and promoting the UPM's participation in international research projects in Educational Technology, and

- take the role of an Educational Technology Information Service to the UPM (news, products, institutions, contacts, conferences, etc.)

As far as organization is concerned, it was decided that GATE would depend directly on the Rector, and that it would be located in the Rectory building itself. It would act as a service to the faculty, on a highly democratic basis.

The creation of the Office represented a real challenge, trying to introduce the use of technological tools in an environment where face-to-face activities were traditionally well established and reluctance to change is great. GATE was structured into different programmes corresponding to the technology groups currently applicable to educational activities: Video, Computing and Telematics. The initial staff of 6 has increased to 10 at the moment, covering management, technical aspects and administration.

The activities performed in the different programmes within GATE have led to the establishment of the embryo of a Technology- rather than a Telecommunications-Supported Training system. The global architecture will be shown later, but for the purposes of this case study only the design and setting up of the Telecommunications components will be analyzed here.

The Educational Telematics (TelEd) team is composed of 2 full-time and 2 part-time members. Following the guidelines of the GATE management, it has been responsible for the analysis, design and development of any project concerning educational applications of Telecommunications in the 1991-1994 period.

The first task to be accomplished by GATE was to explore the huge University environment in order to become familiar with it and get an idea of the sort of

people and conditions that were to be met during the introduction of any sort of technologies. It was not clear which kind of systems were already functioning (if at all), and what the reaction of potential users would be towards new systems.

- *Institutional objectives (A1.1.2)*

The main objective posed by the University was to design a TST system to support the most adequate academic activities within the face-to-face higher education context of the UPM, and explore the scope and possibilities of such sort of system in this kind of environment. The underlying objective, of a more strategic nature, was to offer the image of the UPM as an innovative and advanced university, concerned with the quality of tuition and how to improve it through the use of technologies, and increase the marketability of the UPM products through the introduction of advanced teaching media.

- *Technological culture (A1.1.3)*

The GATE team originally thought that, with the UPM being a technical university, the environment would be highly technology-oriented, both in terms of infrastructure installed in the Schools and attitudes towards the use of applications. It should be frankly acknowledged that we expected to find a large, enthusiastic group of users willing to follow the Office's initiatives.

The reality turned out to be very different from what we had imagined. There was a highly diverse panorama within the different Schools. There were four Schools, focusing on Computer Science and Telecommunications, having a good equipment (obviously, for these Schools a powerful computer and network infrastructure is a must), but functioning on an individualistic basis; they all had their own

Computing Centre, serving their faculty and students with an independent budget. At the School of Telecommunications, most departments have an infrastructure of hosts and LANs for their own private use. This situation gave these centres a high degree of autonomy that made it needless for them to interconnect with the whole University.

For its part, the Rectorry has a Computing Centre which runs the administrative databases and manages enrolment for every course. It is also responsible for the setting up of infrastructure and support to those centres not having resources of their own.

The state of networking policy at the University is one of the direct consequences of the historical independence of the Schools, already discussed above. The three campuses are linked through a voice and data digital network (a service called Ibercom offered by Telefónica). There are plans to integrate every centre into a campus-wide area network, and 7 Schools are already linked over 40kb lines to the Rectorry. The project is expected to cover all the centres by the end of 1994. One of the points of discrepancy among the Rectorry, the Schools and the National Research Network (IRIS) was the electronic mail network. Discussions have taken place concerning the suitability of implementing Internet, EARN or X.400 standards. An agreement was not reached, and eventually every centre involved took its own lead. The Rectorry is now starting to offer Internet services to the Centres, and the basis for collaboration with GATE in this sense is being defined at the moment, but the situation of networking service standards was much less clear when TelEd started its activities in April 1991.

Regarding the users of such technology, their attitudes also varied widely. Most users could barely use a word processor, not many were familiar with the

Windows environment, and the telematics culture seemed to be non-existent in many of the Schools. E-mail has not been greatly promoted in the 15 Schools depending on the Rectory. On the other hand, the need to link computers and the subsequent benefits of sharing resources had not yet arisen in most of the Schools, and GATE information about telematics applications and potential was received with a mixture of indifference and reluctance.

- *Training Culture (A1.1.4)*

The educational culture of the UPM is strongly based on traditional face-to-face learning patterns. As far as this teaching modality is concerned, and taken from the point of view of potential telecommunications support, several experiences have been developed in other countries, that could have guided our design process. However, our context is certainly different; US institutions place great emphasis on the tutoring of their students, who spend all their time closely linked to the University through a campus-based scheme, while the UPM has not such a residential organization, and the teacher-learners relations after regular classes are reduced to a teachers' passive response following learners' initiatives at fixed times. Criteria stated by US colleges in research reports, in the sense of extending classroom activities and facilitating contacts with students after teaching and tutoring hours, are not applicable to the case of Spanish face-to-face University tuition, in which the UPM is not an exception.

Continuing Education has always been an important activity performed by the faculty. The prestige of the University among professionals in the field of Technology meant that an important activity in the Schools is the running of postgraduate courses for companies, professional associations and other universities in Spain. Moreover, some of the Engineering specializations are only

available at the UPM (in some cases, such as Naval Engineering, paradoxically since Madrid is 350 kilometres from the nearest coast!), and therefore teachers have to travel to distant places in order to run their courses.

Despite the face-to-face determinant of the UPM, there is a part of the University's Extension Activities which is carried in the form of Distance Education through an autonomous centre called CEPADE (Centro de Estudios de Postgrado en Dirección de Empresas). This centre specializes in offering Management and Financial postgraduate courses which receive accreditation from the University and can be integrated into a curriculum leading to a Master's Degree. It is managed by teachers from different Schools, who develop the materials, act as tutors during the courses and evaluate learners. CEPADE has been experiencing great success, with a current enrolment of 5,000 students from all around the country.

A final consideration regarding UPM activities which is relevant to our purposes in this case study is the high degree of marketability of the UPM students, who have to pass the University entrance exam with the highest average marks (in some cases, 9 out of 10 points). This fact has meant that students have been practically hired before the end of their studies, with the subsequent problems of compatibility among work and study timetables. The same situation occurs, even more markedly, in the case of those students willing to continue their Ph.D. courses and projects.

The approach to teaching modes and media has been found to be very conservative. Faculty have expressed in meetings and informal conversations that the physical presence of the teacher is a quality requirement in the educational process. They have also referred to their fear of no longer being useful or required if technologies are introduced in their scenarios. Consequently, the scenarios are

characterized by the use of traditional media: blackboard, overhead projector, etc. Video is used to a very limited extent as an aid to traditional teaching. There is also laboratory practice, in which the use of computers and CAL is being introduced very slowly as well.

The following teaching environments were identified at the UPM:

- Formal tuition, regular classes leading to the completion of a degree
- Ph.D. seminars and supervision of theses
- Postgraduate education, leading to Specialization or Master degrees
- Continuing Education, for professionals wanting to update their knowledge, in great demand in this field of Technology
- Distance Education through activities from CEPADE

It became obvious that the first of them was qualitatively different from any of the others, both in student numbers and in terms of the possibility of implementing some sort of technological support. These environments were analyzed in detail in further stages of the design process.

An important point made at this stage was that teachers did not receive any sort of reinforcement, or recognition of their Ph.D. courses and seminars. By contrast, both postgraduate and continuing education were activities students had to pay for, thus constituting a source of income for the teachers and their departments.

- *Commitment to change (A1.1.5)*

What was the strategy underlying the UPM approach to TST? In fact, there was no real immediate need to introduce technologies in any of the scenarios described

above; in this sense, it could be argued that a proactive strategy was followed, in trying to bring about 'the future' to the UPM. However, it is fair to say that at other levels than the Rectory itself, the commitment and interest towards change was scarce. The School, department and above all, the individual commitment had to be considered and treated separately.

- *Intended investment on the part of the institution (A1.1.6)*

The intended investment the UPM was going to put into the TelEd project in the long run was an uncertain factor for us when everything started. As for the initial stages, it seemed to be clear that resources would be allocated for 2 full-time members of staff.

A certain budget for central infrastructure would also be available, but what was very clear to us from the beginning was that there would be no overall policy of equipment lending pools, purchasing on a large scale or anything of that sort. Projects under the TelEd programme would have to be working under the users' current available infrastructure.

Step 1.2 - Identification

- *Intended Scope of the TST System (A1.2.2)*

The system would potentially be offered to the 3,000 teachers at the 19 schools. Only the Faculty would have access to the services, since 60,000 potential users would undoubtedly exceed the Office's resources and control. It was therefore

agreed that students would be allowed to use GATE's services only with the explicit authorization of a member of the faculty.

During the early stages, considerable efforts were made to outline the criteria for the selection of initial pilot experiments and users, though that point would be stated later on in the project. It was our intention to take into account not only the most 'IT-driven' Schools, which were indeed easier to deal with, but also as much as possible to extend the information on Technologies and their functionality to those centres that were less acquainted with the issue.

GATE TelEd services could also be available to external users, that is, actors not belonging to the UPM, in case it was required by the faculty, or whenever a collaboration was agreed with a different institution.

- *Identification of key members of the organization (A1.2.3)*

This was considered one of the crucial issues not only concerning the TelEd programme, but in the proper establishment of the Office in itself. Given the political positioning of the University and the complex relations between the Rectorate and the Centres, to succeed in the UPM meant to succeed in every single School, even in every department, and to do so as democratically as possible. In fact, the GATE Activities Planning and the associated budget had to be approved by the University Management Board, composed of the Rectorate team, the Heads of the Schools and a representation of the students and the administrative personnel. To this purpose, all Heads of Schools had to be contacted and made aware of the services the Office could provide their Schools. The objective of these meetings would be to obtain the reference of a person who would become a member of the embryonic 'GATE human network'. Following this plan, interviews were held with

every Head of School and Faculty, in which three main objectives were set (and unfortunately not always achieved):

- To inform high level management about the new Office and the services it could offer to the corresponding School
- To get information about the state of technology introduction and the groups and environments that would potentially benefit from GATE's activities
- To come up with a list of names for further contacts within the School

This procedure was of great help in obtaining an initial idea of the possibilities of implementing telematics in the Schools. The panorama did not improve with regard to our initial assumptions in this sense: those Centres which were technologically ready to use some sort of Telecommunications were already using their own systems, and therefore did not see the usefulness of GATE in proposing experiences in the field (even if they were using their e-mail only for external contacts and had not reflected on their possible use for educational purposes); and the rest of the Schools thought of Telematics as a futuristic idea, since their infrastructure was so poor in terms of personal computers that linking them into a network seemed too ambitious to consider at that moment. In some of the Centres we managed to get a group of people to act as links for some of the projects, but their willingness depended on their personal interest in the project. This made other kinds of technology more successful than Telecommunications in finding promoters, since a clear view of their applicability in the UPM contexts was more straightforward.

• *TST promoters - Who will 'go first'? (A1.2.4)*

For the running of the pilot experiences, we had to contact specific users willing to test the technologies who would act as 'change agents' within their spheres of influence.

The establishment of contacts after the information the Heads had facilitated was not as easy as we had imagined. Every School is structured into Departments which are in themselves highly independent; again, we concluded that a wider browsing strategy had to be implemented in parallel, if we wanted to find out about specific 'targets' for our activities. Having this situation in mind, we decided to mail a very simple survey of interests in Educational Technology to the whole faculty, channelled through the Heads of Schools and Departments. We hoped that would enable us to draw a 'Map of the current state of Technologies in Education at the UPM', that is, a database of contacts that would represent a step forward in our human network.

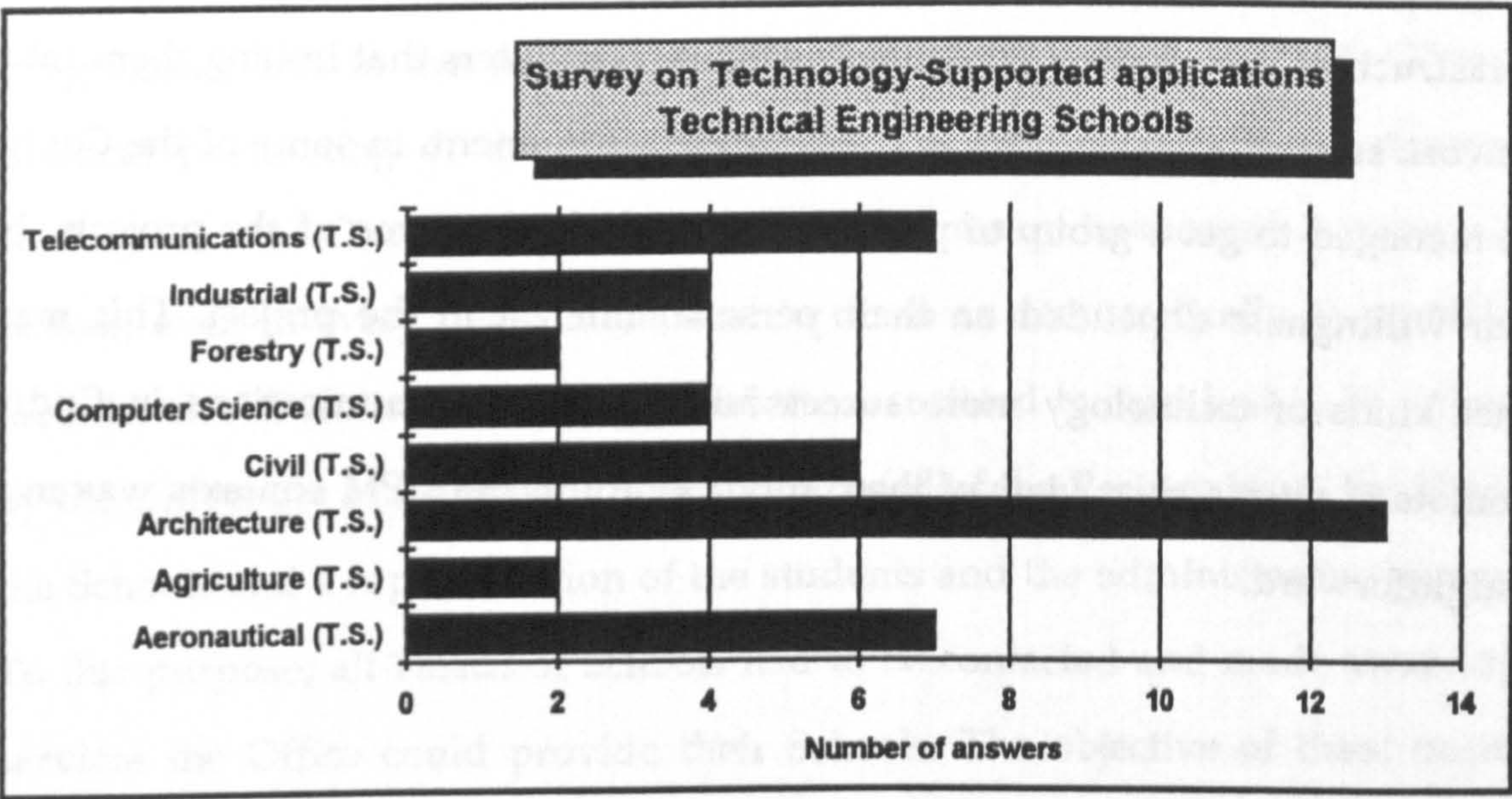


Figure 5.2 - Distribution of answers from Technical Schools (3-year)

98 completed questionnaires were sent back from 17 Schools (some questionnaires reflected the opinion and interest of a group of teachers concerned with a research area, and not only an individual's response). The results of the Survey are shown in Figures 5.2 - 5.5, in terms of the number of responses per School, the degree of involvement in the field, users' estimation of potential educational application scenarios for IT, and the type of technology addressed.

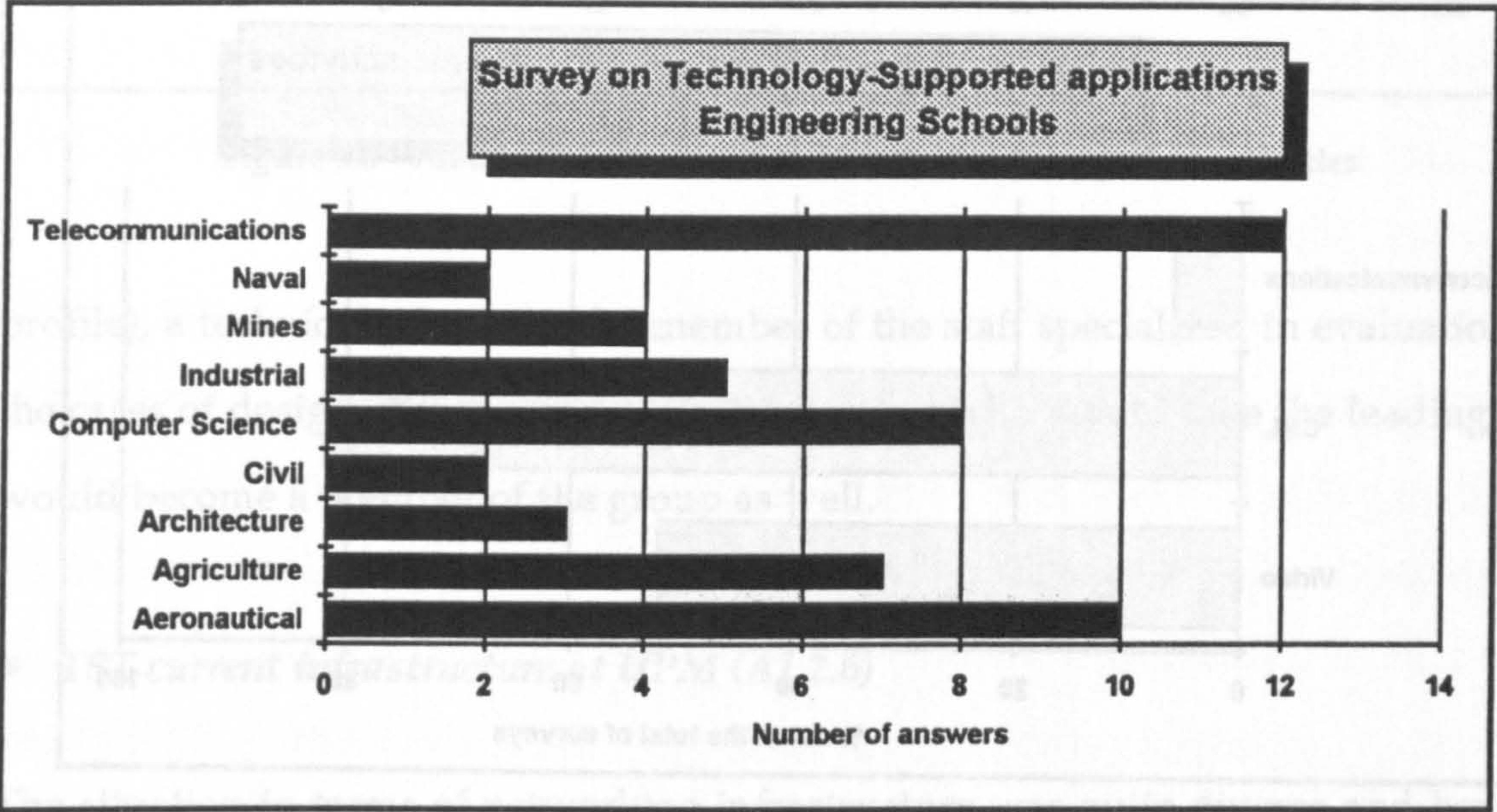


Figure 5.3 - Distribution of answers from Engineering Schools (6-year)

Reactions from the faculty mainly concerned activities consisting of educational video and computer science. Interest in the telematic field was only expressed in 6 questionnaires. This result gave us a clearer idea of the low level of awareness on the part of UPM teachers regarding the Telecommunications technologies and their potential applications. As for the scenarios considered by the teachers as most suitable for the implementation of technologies, they were widely distributed among regular tuition, lab practices and postgraduate and continuing education.

The low level of awareness of Telecommunication applications indicated the need to focus our activities on the level of promotion or even advertising. Our original idea that the objective in this case was to generate a "culture of telematics use" was reinforced, and determined the design of the Adoption Strategies that will be described later.

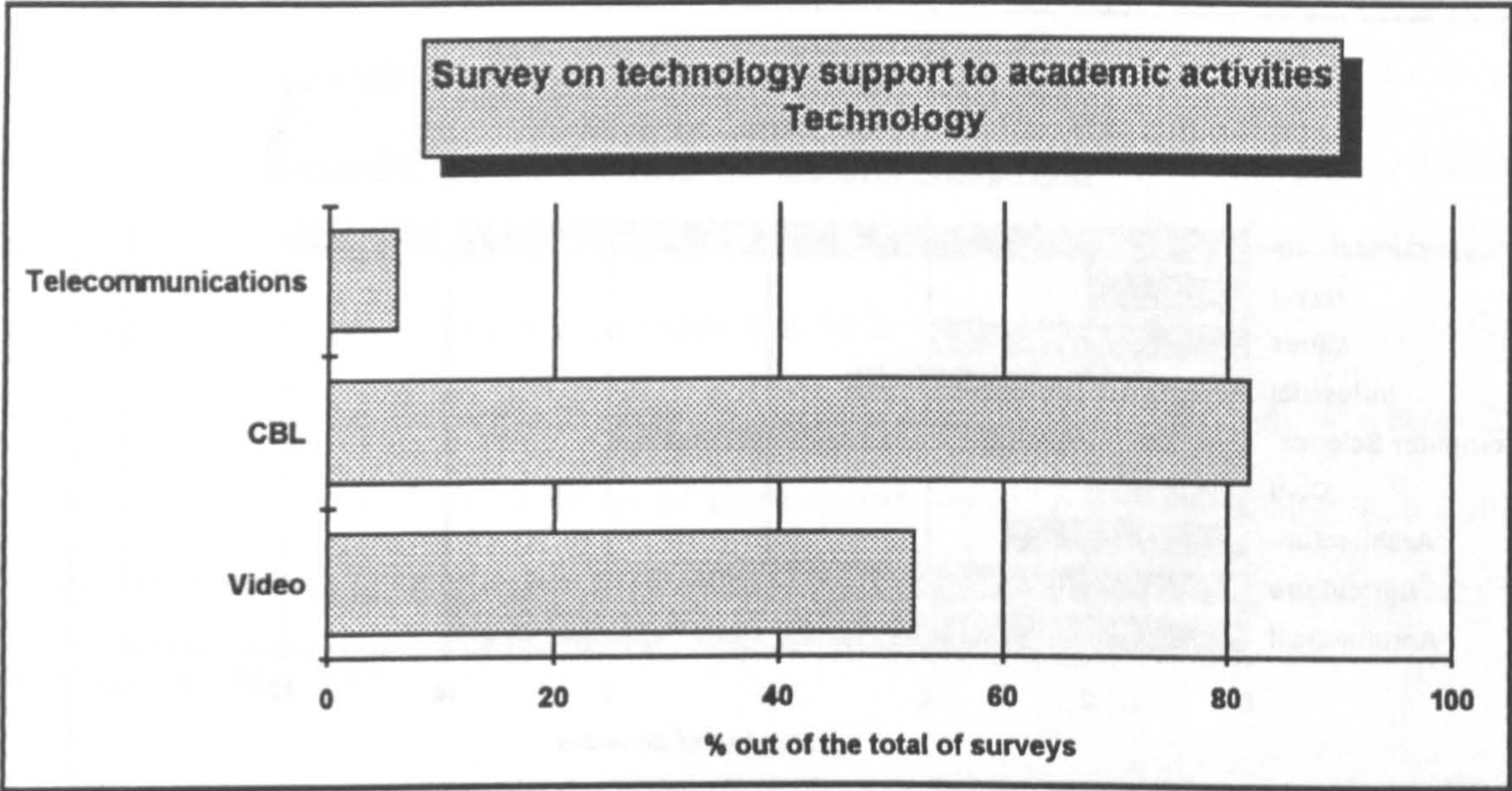


Figure 5.4 - Interest shown in the different types of technologies

• *Creation of a Project Team (A1.2.5)*

It was decided at this point that the project team would be composed by GATE members who under certain circumstances would bring specific actors into the group. The core team was composed by a coordinator (with an educational

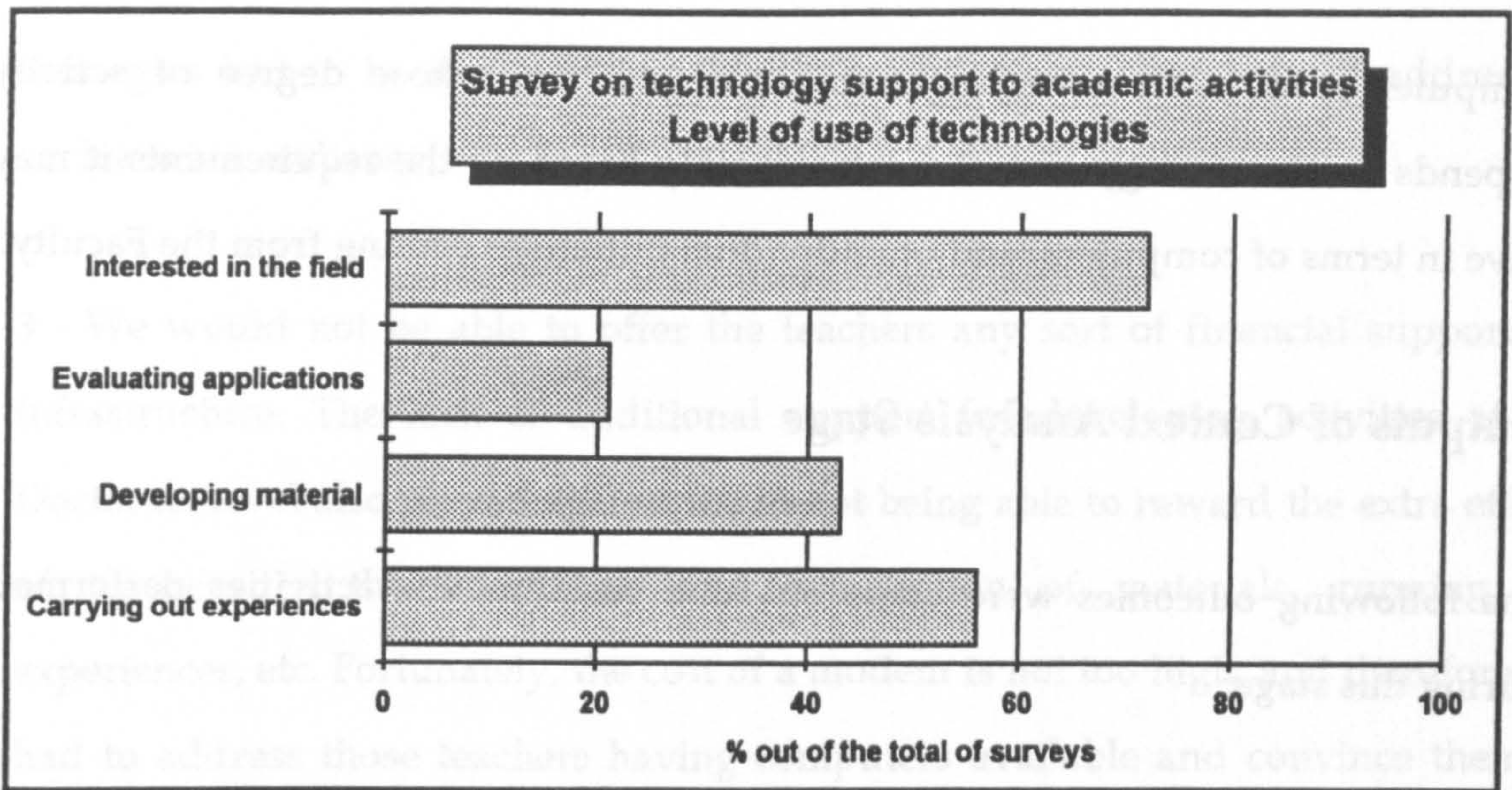


Figure 5.5 - Faculty's degree of involvement in IT-supported activities

profile), a technical person, and a member of the staff specialized in evaluation. In the cases of design of the experiences, the teacher who would take the leading role would become a member of the group as well.

- *TST current infrastructure at UPM (A1.2.6)*

The situation in terms of networking infrastructure was quite diverse and beyond the control of GATE, which had no control over that project. Rather, our role would be to try to make use of the existing and future infrastructure, as implementation was being completed.

As for the equipment available to teachers to connect to our still hypothetical telematic system, diversity was again in evidence. It ranged from 'every teacher having his/her own computer linked to a TCP/IP network' to 'no computers and no network'. The most common situation was that of a group of teachers sharing a computer with no connection facilities, far from a telephone line; nor a very encouraging situation. Regarding the facilities for students, every School has a

computer room with a varying number of stations, whose degree of activity depends on the strategy of each centre, mainly based on the requirements it may have in terms of computers, and on individual initiatives coming from the Faculty.

Outputs of Context Analysis Stage

The following outcomes were come out as a result of the activities performed during this stage:

- Definition of objectives for GATE - translation into equivalents for the TelEd programme.
- Initial contacts with UPM centres - identifying potential promoters and higher level interaction (Director of GATE - Heads of Schools).
- Setting out the driving forces and boundaries of the TelEd activities.
- Creation of the initial TelEd team to start the analysis and design process.

The conclusions that the TelEd team drew from the analysis of the UPM context were the following:

1 - The institutional objective of offering a service to the whole UPM meant that the designed architecture should be useful to a wide range of users, from technologically-advanced Schools to the most conservative, traditional ones.

2 - We were facing a highly unaware and reluctant group of users. In fact, of all the types of technologies covered by GATE, those based on Telecommunications were the ones that most raised the question of the removal of the physical presence of the teacher . Therefore, we had to carefully search for the proper arguments to use in each of the Centres, in relation to their specific working areas. The Adoption

Strategies had to be designed in a highly modular and open way, if addressing such a wide audience.

3 - We would not be able to offer the teachers any sort of financial support for infrastructure. The lack of additional support for developing activities at the Doctorate level also played against us, in not being able to reward the extra efforts of teachers in the adaptation and preparation of materials, running the experiences, etc. Fortunately, the cost of a modem is not too high, and therefore we had to address those teachers having computers available and convince them to purchase a modem if they were not already linked to the UPM network.

4 - It was already obvious to us that many of the current face-to-face scenarios were not especially open to improvements through the introduction of Telecommunications technologies. However, as a result of this context analysis we identified a group of situations that might well be supported by these type of technologies; they were those in which a problem of coincidence in place and time among the actors emerged. The postgraduate scenarios, as well as coordination within many of the departments, and continuing education involving in-service professionals were indeed scenarios in which TelEd support could result in more effective development of the faculty's professional activities.

Stage 1 - Context Study
Key Actions and Results

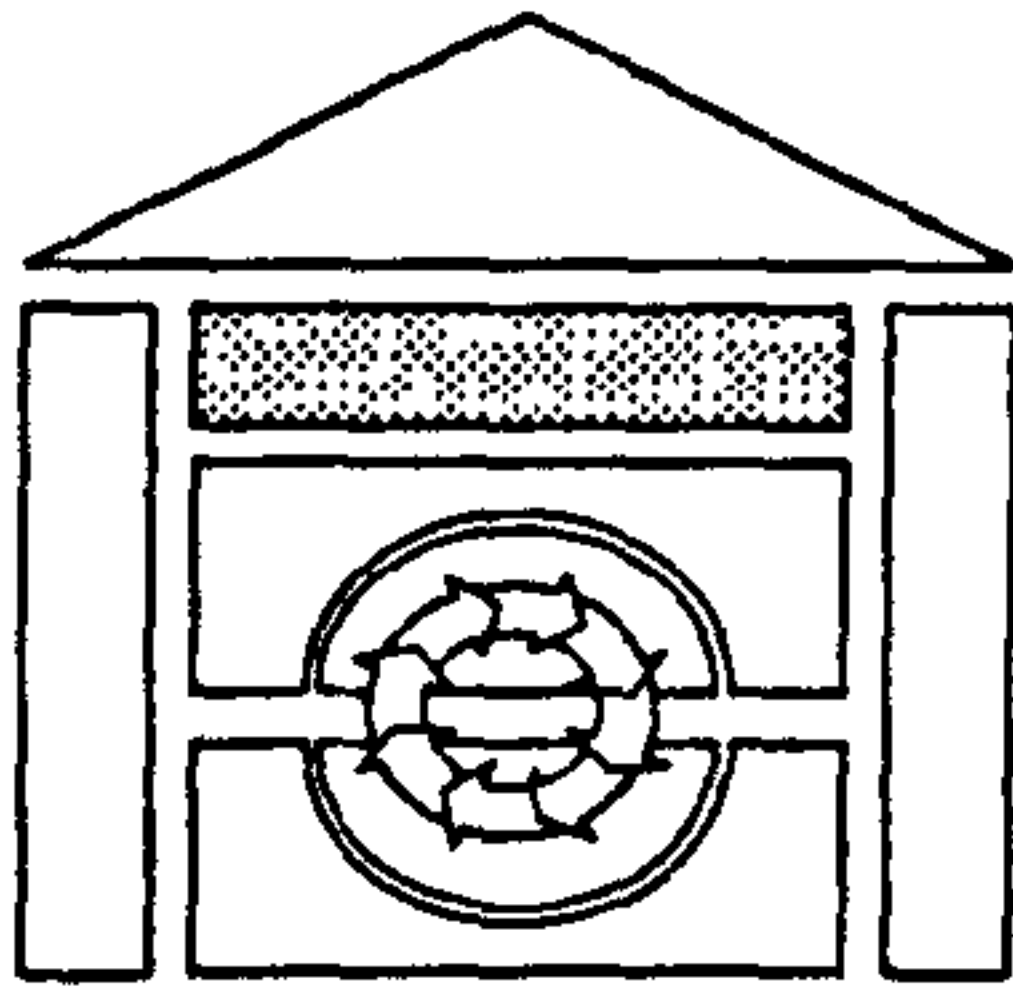
Step 1.1 - Analysis

- *Structure* - Highly heterogeneous University - Large independence of Schools. Requiring separate approach strategies.
- *Coverage* - GATE as a service to the all the Faculty. Open to external institutions under definite criteria.

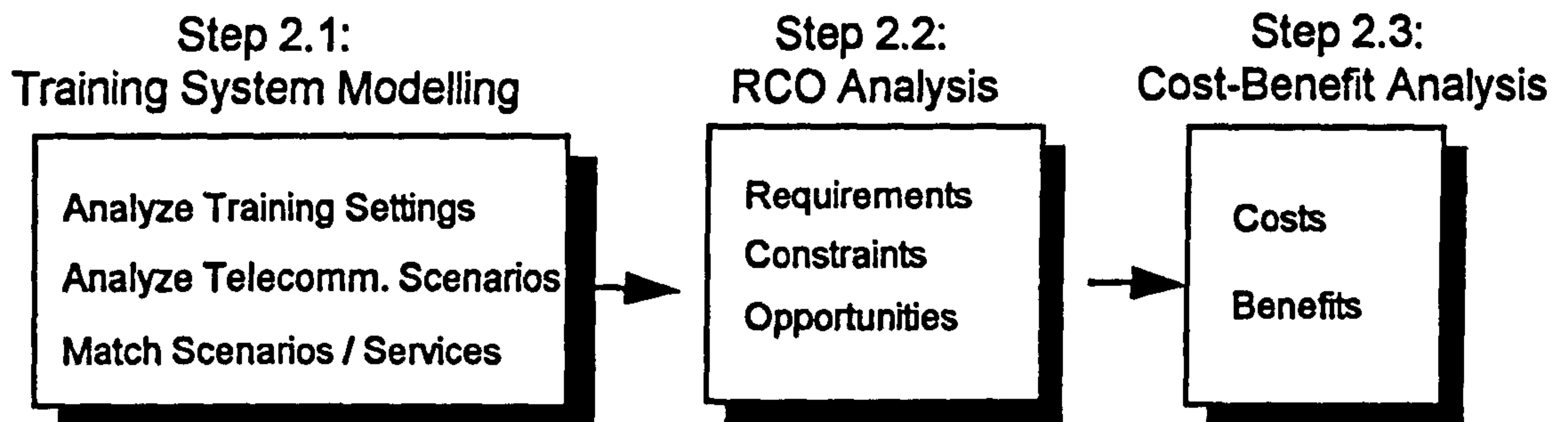
- **Technological culture** - lower than expected. Widely varying with the Schools. Conservative in general. Infrastructure depending on Schools as well. UPM-LAN plans in progress (7 centres currently linked). E-mail policy sparse, not integrated, combining Internet and EARN.
- **Training culture** - Face-to-face, conservative methodologies and support. High rate student : teacher. UPM very active in Continuing Education. Lack of acknowledge for teachers' Ph.D. activities. Scenarios defined:
 - Formal tuition
 - Ph.D. seminars and project supervision
 - Postgraduate Education - Master degrees
 - Continuing Education
 - Distance Education - CEPADE centre
- **Intended investment** - to cover central infrastructure and GATE personnel, but not users' infrastructure
- **Key persons** - Interviews held with all management in Schools, trying to create a 'human network'.
- **TST Promoters** - Survey to all faculty. Results: very low degree of awareness of Telematics applications. Adoption strategies would have to start at initial diffusion level.
- **TelEd team** - composed by people with Educational Technology background. Plans to rely technological 'hard' activities on UPM workforce, mainly collaborations with Schools and pool of scholarships.

Step 1.2 - Identification

- **Potential promoters in Schools** - for the design of Pilot Experiences
- **Project team** - GATE TelEd programme team for TST design
- **Current infrastructure** - difficult to find out. Varying greatly in Schools.



5.2.2. Stage 2 - TST System Analysis



Following the conclusions stated as a result of the context analysis, the next stage addressed the definition of a technological architecture able to effectively support the activities we had detected. In the first instance, we had to analyze such activities in detail, in order to transform them into telecommunications parameters that would suggest the most suitable services to be implemented for the UPM.

Step 2.1 - Training System Modelling

- *Training Settings (A2.1.1)*

As was identified during the previous stage, the criterion of supporting the *lack of coincidence in space and time* shaped the definition of the UPM training settings, which are shown in Table 5.2. It was derived from the Context Analysis that in a face-to-face context like the UPM, the support that the faculty might expect from Telecommunications depended on bridging the problems of coincidence in time, and therefore the capacity to create virtual meeting points with colleagues and students, both for communicating and exchanging

<i>Activity</i>	<i>Roles involved</i>	<i>Inputs</i>	<i>Outputs</i>
1. Classroom Teaching	Teacher Learners from UPM	Lecture Scripts	Lecturing, questions and answers, discussion
2. Tutoring and Counselling	Teacher Learners from UPM	Problems, questions, requests for info and further study...	discussion, information exchange
3. Postgraduate courses	Teachers Learners: from UPM from companies from home	Lecture Scripts	Lecturing, questions and answers, discussion
4. Supervision of projects and PhD thesis	Supervisor (teacher) Student	Work in progress Questions, request for info	Work monitored and corrected, discussion
5. Academic management	Faculty members Administrative personnel	News, notes, initiatives, suggestions of decisions	Agreements, questions, discussion, closer management progress
6. Research Fora	Faculty Researchers out of the UPM	Ideas Subjects for discussion Documents	Exchange of opinions, info, collaborative work
7. Distance Education		Course script	Course materials
7.1. Design and development	Teacher		
7.2. Course delivery	Administrative staff Learners	Documentation Other materials	Learners ready to start
7.3. Course running	Teacher Learners	Assignments questions, requests for info	Corrections, comments, discussion

Table 5.2 - UPM training settings

material. The TelEd team collected and studied those settings that teachers mentioned in multiple interviews and conversations during a period of 3 months. The interviews focused on the exploration of typical work situations arising in their contexts, and communication problems they might find; we then suggested possible ways of improving the situations with the use of a telematic system and what that would imply, and observed and monitored their reactions, attitudes towards the idea, comments, etc.

As a result of the process, the settings considered for further analysis of Telecommunications Scenarios were:

- *Lecturing - regular classroom teaching*

Traditional lectures are characterized by a one-to-many dynamics. The materials used during the classes consist of books, notes and overheads shown by the teacher. The use of video and other media is at the moment very occasional.

- *Tutoring and Counselling*

Though tutoring activities associated with regular tuition were regarded as inadequate for TST by the faculty, mainly because the large number of students, some of the teachers mentioned a case that might be improved by the use of telematics. It was the case of students in their final years who had still not passed a subject from a previous year. This is a very common situation in the UPM, since it is not essential to pass many of the subjects in order to make progress in the curriculum. For this reason, students leave them aside, and have to pass them in conjunction with their current year's activities. Timetable problems in attending classes make it especially difficult for learners to catch

up, and the setting up of a permanent communication point with the tutor could help learners to complete their curricula more comfortably.

- *Projects and Ph.D. supervision*

A very common situation within the UPM is the supervision of final projects; they require a close teacher-student interaction over a limited time span to define, complete and present the project in order to obtain the Engineering degree. As this activity is compulsory, teachers usually have a large number of students to supervise simultaneously, thus overrunning their available time. A similar situation is the supervision of Ph.D. projects; in this case, the time span of the relation between teacher and student is much longer. Both settings would require the exchange of documents for revision and discussion.

The reaction of teachers to the introduction of a telematic support in this setting was highly positive. The need to meet face-to-face with individual students on a frequent basis took a lot of time and effort that could be alleviated by this new form of communication. It was recognized, moreover, that students would probably feel more comfortable if they were able to ask a question or make a comment whenever they felt like it; by contrast, teachers foresaw the greater effort it would take on their part to write down comments, check for new messages frequently, etc.

- *Postgraduate / Continuing Education courses*

Both in the cases of higher degree and continuing education, courses are lectured on a face-to-face basis, with students coming from their work places to the University or to institutions that collaborate in the organization (Chambers of Commerce, Professional Associations, etc.). Teachers also frequently participate in courses in other provinces, given the lack of experts in several

Engineering areas. The dynamics of these postgraduate courses, mainly short modular seminars leading to Masters' degrees, is very similar to the first setting described, Classroom Teaching, with the teacher lecturing and exchanging books, printed materials and transparencies during the classes. However, the existence of a large potential group of learners who live and work at a distance makes this setting more interesting for teachers, who see a business opportunity in virtually extending the classroom. They are also aware of the need in this hypothetical case, to adapt materials to a distance education format, which may be costly in terms of money and effort; equally, the handling of large groups electronically would require additional efforts on their part.

- *Academic management*

The complex, sparse organization of the UPM into autonomous Schools requires a complex infrastructure to carry out administrative, bureaucratic and management tasks. The department of Foreign Languages is the most striking example of this situation, covering a group of 60 teachers who are spread over the 19 Schools. A fluent and effective communication system is also a requisite for this sort of task, and in this sense it was thought that the larger potential of telematics, especially through the use of an asynchronous tool, would prove very enriching for group dynamics and management.

- *Research Fora and meetings*

The UPM is one of the first in Spain to develop research projects funded both nationally and internationally. The need to follow the works of other partners, as well as the establishment of contacts with colleagues in other countries is also a large field of activity for the faculty. Group work and effective communication is expected from this setting, and consequently it was often

quoted among the teachers as a possibility for testing the applicability of Telematics as well.

- *Support to Distance Learning*

Within this setting traditional Distance Education activities take place; learners receive documentation from CEPADE, and interact with their teachers over the telephone during the course period for tutoring purposes. There is also a regular process involving the submission of assignments by ordinary mail, and corrections are sent back through the same medium. There is also a final examination, requiring learners to come to Madrid from different provinces.

Teachers who run the management of this setting were very interested in testing out the usefulness of a TST system around three tasks:

a. Delivery of materials: traditionally, materials have been sent by ordinary mail. In the case of large documentation, this is still the most effective way. Nevertheless, there is a certain information about news, administration, etc., that might be more effectively sent through other media resulting in early and safe arrival.

b. Submission and correction of assignments: practically every month, learners have to send to their tutors a 2-3 page written assignment, which is sent back to them with the corresponding corrections and comments. The current organization takes the following route: 'student - CEPADE Central Administration - tutor - CEPADE Central Administration - student'. A more direct way of establishing the student-tutor relation for this task would dramatically speed up the process, requiring at the same time fewer central resources at this point.

c. *Tutorial activity*: teachers who have to run tutorial sessions on the phone frequently claim that it is difficult for them to keep to timetables; on the other hand, students have complained about the impossibility of finding the tutor at the stated times. A more flexible tutorial system, allowing peer interaction for added benefit, would be worth testing.

- ***Telecommunication Scenarios (A2.1.2)***

The telecommunication scenarios coming out of the settings, summarized in Table 5.3, are:

- ***Teaching***: Requiring the exchange of text and occasionally graphics. This scenario has a wide scope, establishing a one-to-many communication form (traditional lecturing). Synchronicity is required for this kind of activity.
- ***Tutoring***: In this case, small groups (mainly dyads) exchange short text messages, on a local basis for ordinary UPM activities, but potentially involving people from all over the country in the context of Distance Courses. The communication established in this case is one-to-one, and time coincidence is not necessarily a requirement.
- ***Supervision***: In a very similar way, the supervision of projects is conducted mainly on a local basis, and in a one-to-one communication form, but in this case the information exchange may involve more complex and larger documents, shorter messages being a complement to discussion.
- ***Group meeting***: Both for the Academic Management and Research Fora settings, a scenario can be foreseen in which discussions and conferencing are the main functionalities. With local, national or even international scope,

Scenario	Activity	Info. requirs.	Grouping	Coverage	Comm. form	Synchronicity	Functionalities
Teaching	1	text, graphics	Large Small	From local to national	one-to-many	synchronous	lecturing
Tutoring	2,7	Short texts	small	from local to national	one-to-one	Both	q&a correction of assignments
Supervision	4	text (complex documents)	small	local	one-to-one	both	discussion
Group Meetings	5,6	short texts	small large	local national international	many-to-many	asynchronous	discussion
Delivery	7	Long documents, other materials	large	national	one-to-many	asynchronous	sending of materials and info

Table 5.3 - UPM Telecommunication scenarios

a many-to-many communication would be needed, with no real-time requirements. Information transmitted would be in the form of short texts (messages, news, etc.).

- ***Delivery:*** Especially in the case of Distance Education courses, the delivery of materials to students would involve the sending of large sets of documents from the headquarters in Madrid to distant points in Spain. Besides this first delivery, a lot of information is periodically sent to the students during the time that the course is in operation, concerning enrolment, administrative data, the promotion of new courses, etc.

Table 5.4. shows the different Telecommunications Services that may support the scenarios coming out as a result of the modelling process.

Step 2.2 - Analysis of Requirements, Constraints and Opportunities

The TelEd team had already been identifying a good number of conditions that would constitute requirements and constraints for the decision on the architecture to be implemented. The statements came out of the interviews and meetings we had with different groups within the faculty.

- ***TST system requirements (A2.2.1)***

These are directly determined by the lack of technological culture and motivation on the part of the largest section of potential users identified. For the initial stages, we had to offer something so easy to use that it would compensate the teachers' estimated effort to learn and actually use the system.

Scenario		Service	Network
Teaching		Broadcast	Satellite
		Videoconferencing	ISDN
Tutoring Supervision Group Meeting		E-mail	PSTN
		Computer Conferencing + attachment facility Videoconferencing	PSDN ISDN
Delivery		Mail	Post network
		File transfer	PSTN

Table 5.4 - Correspondence Telecommunication Scenarios - Telecommunication Services and Networks

The idea was to offer a 'first aid' architecture that would set the basis for the creation of a telematic culture, and that would serve as a bridge for the future implementation of more advanced systems. The requirements detected were:

- **Language of the interface** - The end user interface would be in Spanish, as a first condition; people would not use an interface in English, it would add too much complexity to its use.
- **Wide Accessibility** - The system should be accessible from the widest possible range of equipment. Many of the potential users had in their rooms old 286 PCs with low graphics capabilities, which for example invalidated the use of Windows as an extended interface. Nevertheless, it would be desirable that the system also made the most of those users which were in better condition. Along the same lines, the most frequent situation was that users would be able to connect through PSTN, either from their department rooms, or from their companies or homes in the case of external users (continuing and distance education).
- **Reliability of the system** - The system would have to be built with very reliable and tested technologies; we could not take the risk of teachers' feeling like 'guinea pigs' in the face of a technology still being tested.
- **Distributed management** - the system should allow for a distribution of coordination functions in different centres: administration, technical support, maintenance, etc.
- ***TST system constraints (A2.2.2)***
- **Low budget** - The resources allocated to infrastructure would be highly limited; it would not make sense for GATE to set up an independent technical infrastructure, being as it was a Rectory service for a University that has a large technical infrastructure. We would have to obtain support from one of the computing centres.

- **No resources for users** - Also with regard to finance, we would have no budget allocated for users' infrastructure; a teacher wanting to become a user of the future TST system would have to pay for his/her own equipment. This constituted a very severe limitation, that as will be seen later, has largely determined users' participation in GATE's telematic experiences.
- ***TST system opportunities (A2.2.3)***

For the Institution:

- Setting up of an innovative service, experimenting in the field of Education
- Augmenting the communication possibilities of the UPM
- Extending the business (e.g., increasing the students in continuing education)

For the Faculty:

- increase the possibility of coincidence with interested colleagues and students for a more flexible development of their academic activities.
- offer the opportunity to experiment with a new teaching medium, receiving support in getting to grips with the tools and in designing their own activities.
- open a set of opportunities with the postgraduate courses they were then offering, by allowing access to the contents and enabling the teacher to address a much larger audience. Teachers could thus offer the same courses on a Distance Education basis, adapting the materials and carrying out the tutoring through Telecommunications technology.

For the students:

- increase the accessibility of materials
- increase their contact with tutors

- introduce greater flexibility in the delivery of materials (in Distance Education)
- improve the submission and correction of assignments (idem.)

Step 2.3 - Cost Benefit Analysis

Different perspectives were taken with respect to cost-benefit factors:

1. *Institutional approach*: the most suitable investments for implementing the adoption strategies and pilot experiences.
2. *Users approach*: costs associated with the enrolment and running of specific experiences and to steady use of the UPM TST system.
3. *Pilot experimentation approach*: required investments from GATE and users for each experience.

These costs were compared as far as possible with the corresponding financial and utility (abstract) benefits, which have already been described as 'Opportunities' in the RCO analysis (A2.2.3).

• Institutional costs (A2.3.1)

Bearing in mind the initial budget constraints, the users' requirements and the general objectives of the programme, it is possibly fair to say that the design solution was rather clear in our minds at this moment of the process, in terms of some sort of asynchronous, computer-based conferencing service. An alternative offering real-time video communication would require the use of networks not available at the UPM at that times.

In order to illustrate the main costs considered, a list of concepts and their financial estimation are presented:

Main infrastructural investments:

Concept	Cost (in Pounds)
Computer Conferencing software	6,400
Modems	700
Communications Software (selection of packages)	1,000

Annual costs:

Concept	Cost (in pounds)
Facilities and premises	UPM Rectory building and facilities
Personnel	
• GATE full-time	115,000
• GATE part-time	41,000
• Other (Scholars)	10,000
Equipment	
• Leasing and paying-off (3-year)	2,000
• Maintenance	1,000
• Software licenses	—
• Telephone charges	Rectory infrastructure
• Other	1,000
Materials	1,300
Other general costs	
• Travel	3,500
• Information activities	1,000

- *Institutional benefits (A2.3.2)*

Taking into account the University experimental environment and the main goals of the programme, it would be unreasonable to compare the costs with financial benefits. Actually, the aim was not to use the system as a substitute for any face to face activity, but to start up new training activities and opportunities (see A2.2.2). Consequently, cost analysis rather focused on the estimation of the availability of budget for the outlined architecture than on a quantitative comparison of costs-benefits.

The costs-benefits associated to the pilot experiences performed will be discussed later when the activity of resources estimation (A3.4.5) is described (Step 3.4: Design Pilot Experiences).

Outputs of TST System Analysis Stage

- Analysis of the Training Settings causing coincidence problems in the UPM open to improvement with technological support
- Analysis of the Telecommunication Scenarios generated by these Settings
- Cost-Benefit discussion

Stage 2 - TST System Analysis

Key Actions and Results

Step 2.1.- Modelling

- Criteria for the analysis: activities requiring coincidence in space and time
- Training settings (from interviews with the faculty):
 - Formal tuition
 - Tutoring and counselling
 - Ph.D. and projects supervision

Postgraduate / Continuing Education courses

Academic management

Research Fora and meetings

Support to Distance Learning

- Telecommunications Scenarios

Teaching (lecturing)

Tutoring

Supervision

Group meeting

Delivery of materials

Step 2.2 - Analysis of R-C-O:

Requirements:

Easy-to-use interface

Reliability of the system

Support from distributor

Modular functioning

Constraints

Low budget

No resources for users

Wide accessibility

E-mail policy

Opportunities

Institutional

Innovative image (1st TST University system in Spain)

Improvement in communication with the faculty

Faculty

Increase contacts and interactivity with peers and students

Opportunity to experiment with new media

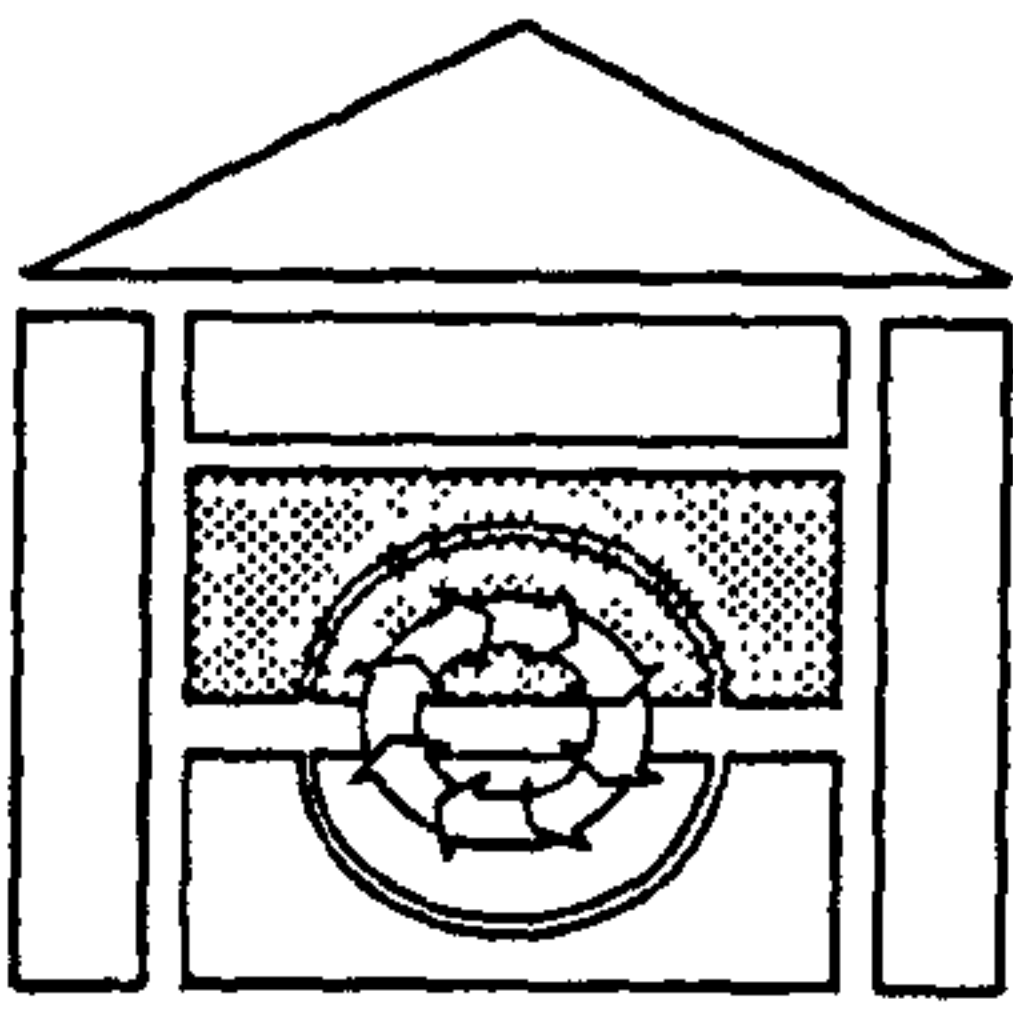
Extend postgraduate activities

Increase accessibility to materials for students

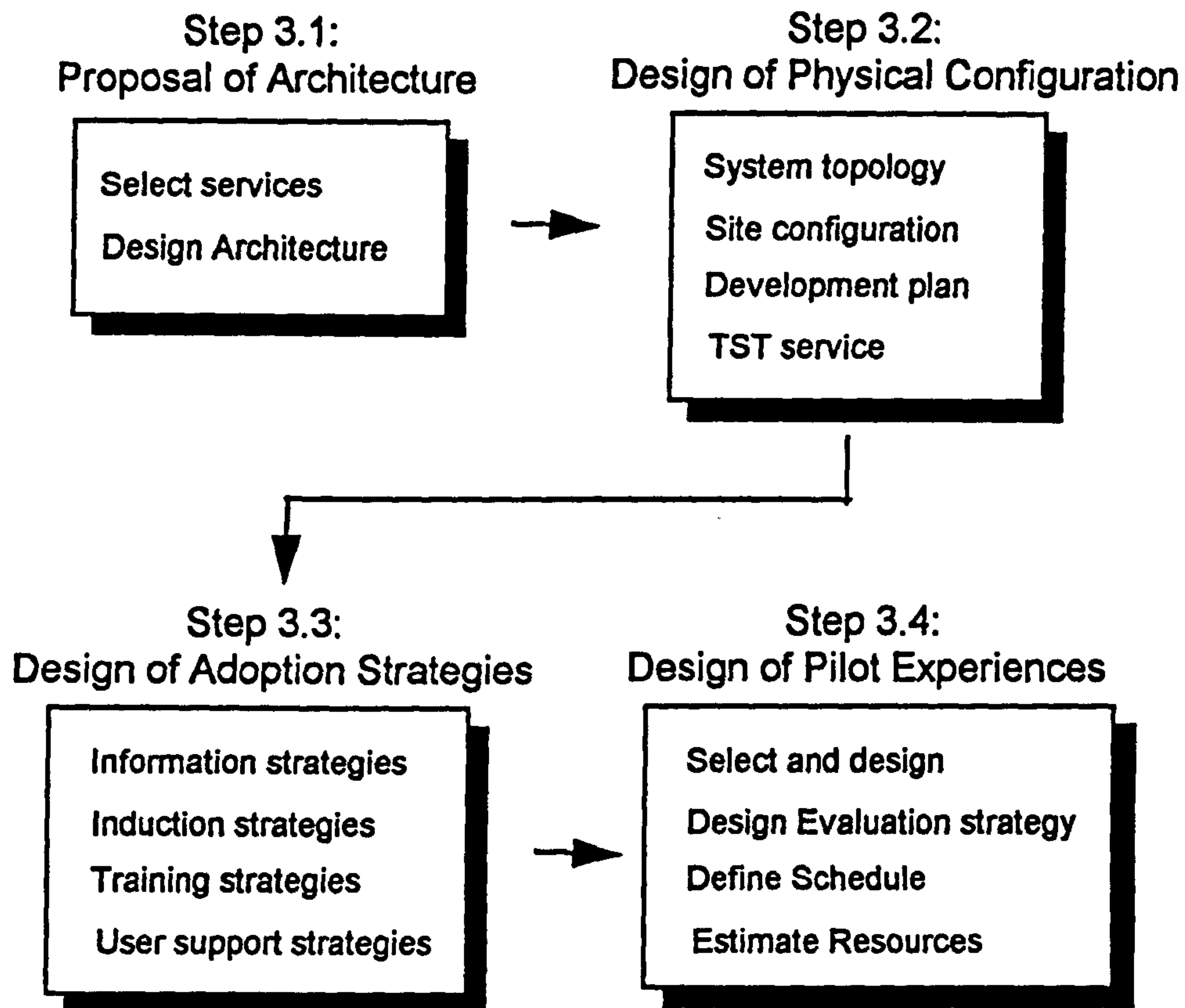
Step 2.3 - Cost Benefit Analysis

Estimation of costs

Estimation of benefits



Stage 5.2.3 - TST System Design



In the light of the conclusions of the context study and the TST system analysis, an architecture was designed to carry out the training activities previously identified and modelled. The main goal of the design is to minimize the implementation efforts and to optimize the final system performance. This was achieved by finding the most suitable functional arrangement of Telecommunications components and adoption strategies for the training settings modelled during the System Analysis Stage.

Step 3.1 - Proposal of Architecture

- ***Select Telecommunications services (A3.1.1)***

Table 5.4 shows a relation of services that might support the functions and tasks analyzed in the training settings, and which were suggested as a result of the modelling process in the former stage. Two different groups of technologies arose as characteristic of the UPM scenarios:

- On the one hand, the long and stable face-to-face tradition would make it reasonable to introduce a kind of real-time technology that emulates 'interactive presence at a distance'. The most representative is obviously videoconferencing, and it would cover the scenarios involving lecturing and some types of group meeting.
- A second type of technology would bridge the problem of coincidence in time that was described in so many cases by teachers as a substantial limitation to their duties. Computer Conferencing or applications through e-mail were obviously recommended in this case.

Regarding the networks over which these services might run, asynchronous Computer Conferencing or e-mail would be accessible from PSTN or data transmission networks. Video transmission obviously requires a more sophisticated network, either via satellite or over ISDN wherever it is already installed.

What issues would rise from filtering these different architectural solutions through the requirements and constraints identified above?

1. Firstly, the costs of the equipment in the case of videoconferencing are much higher than the budget assigned for the TelEd programme. This would clearly make the investment in the short term impossible. However, given the importance that this kind of technology could acquire at the UPM, as detected in the interviews with the Faculty, the idea of testing out a Videoconferencing service was carefully considered.

2. Networks currently available also represent a serious limiting factor in making the final decision, considering the choice between real-time and asynchronous technologies. ISDN installation is progressing very slowly in Spain. Likewise, the high costs of satellite networks would not make its use advisable. Consequently, the networking factor reinforced the idea of retaining the videoconferencing technology for a medium-term implementation phase.

As far as asynchronous technologies are concerned, there is an advantage in their being accessible over the public telephone network. Teachers and students from UPM could log in from their University rooms and Computer classrooms, and also extend the facility to their own homes at a reasonable price. The system should also provide access through data networks, X.25 and TCP/IP, both for the Schools with computers linked to LANs, or for professionals outside the UPM who might connect from their workplaces. These factors outline Computer Conferencing as a more realistic telecommunications service than real-time videoconferencing technologies.

3. Other factors, such as the problems encountered in coordinating the centres regarding the establishment of a common e-mail policy, the lack of uniform infrastructure in the Schools, and the need for GATE to have control over some of the management functions of the TST, in order to have freedom to design and support the experiences that the faculty progressively suggested, made the balance tip in favour of the Computer Conferencing as a short term solution.

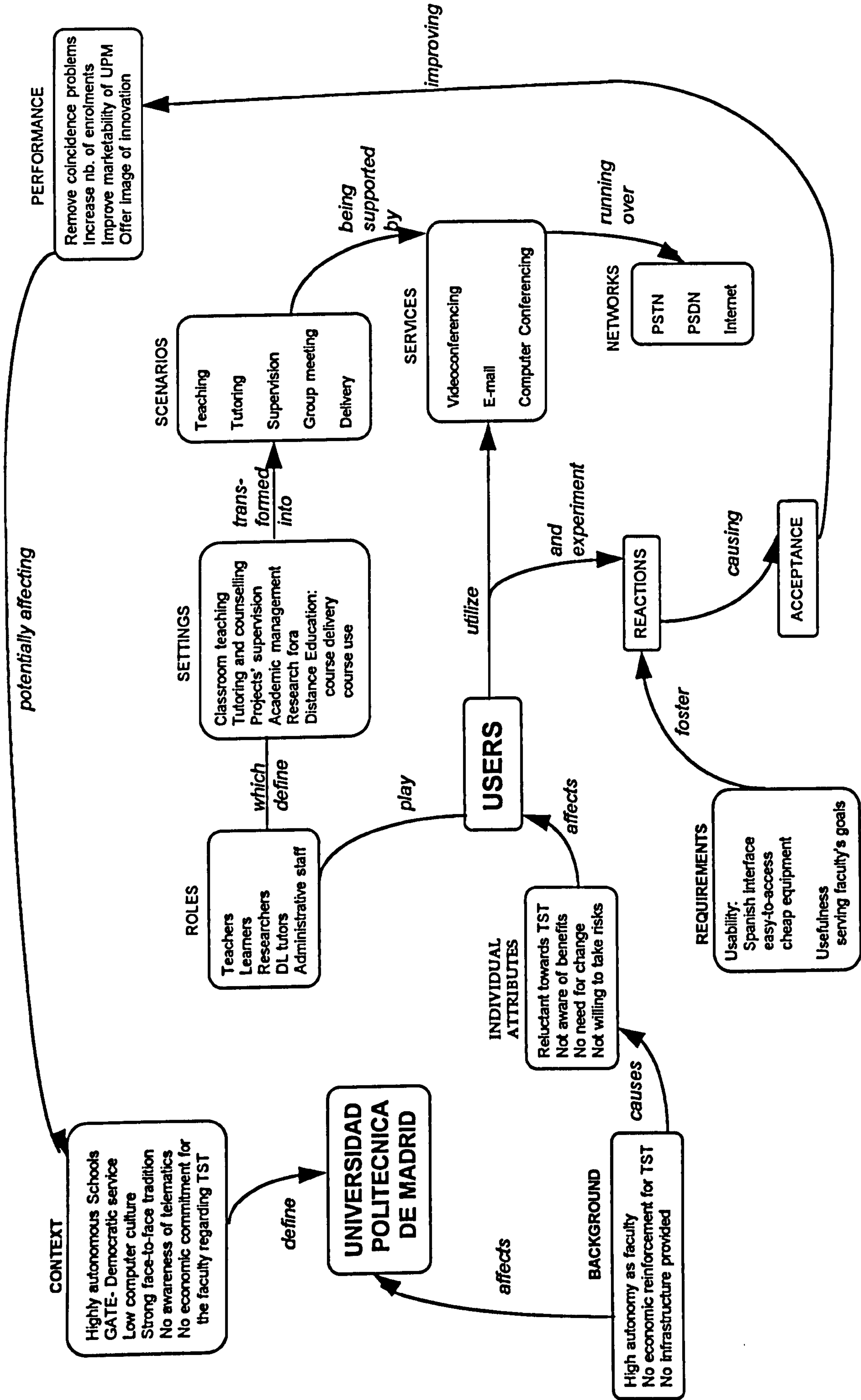


Figure 5.6. The TST Model of the UPM

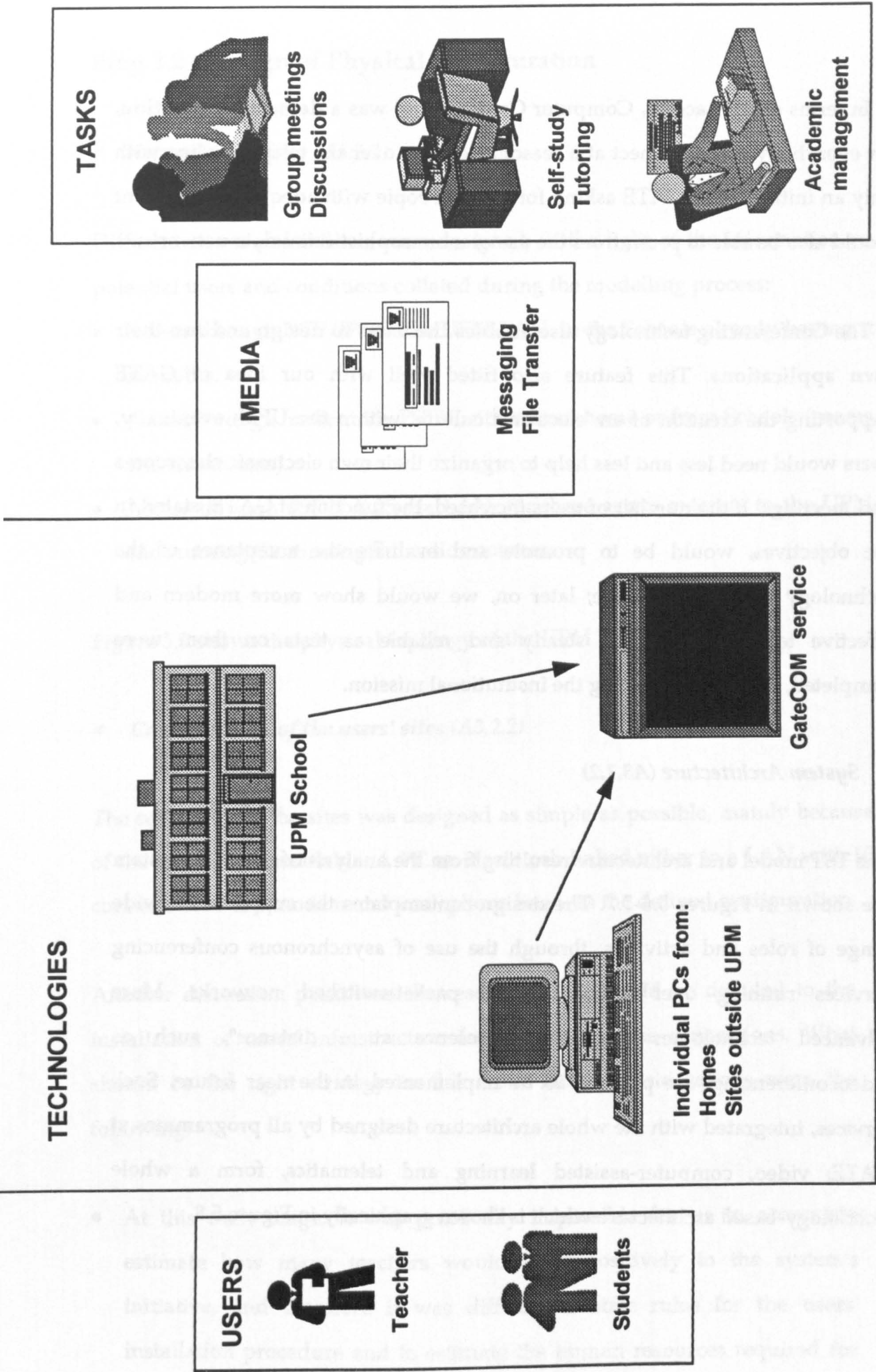


Figure 5.7. UPM TST System Architecture

4. In terms of user access, Computer Conferencing was a democratic solution, for everybody could connect at a reasonable price over the telephone line with only an initial call to GATE asking for an ID. People with adequate equipment would also be able to profit from the use of more sophisticated data networks.

5. The Conferencing technology also enables the users to design and run their own applications. This feature also fitted well with our idea of GATE supporting the creation of an 'electronic culture' within the UPM; eventually, users would need less and less help to organize their own electronic classrooms and meetings. If the number of users increased, the function of GATE, stated in the objectives, would be to promote and evaluate the acceptance of the technology in an initial stage; later on, we would show more modern and effective technologies to be steady and reliable as tests on them were completed, thus accomplishing the institutional mission.

• *System Architecture (A3.1.2)*

The TST model and architecture resulting from the analysis of the UPM system are shown in Figures 5.6-5.7. The design contemplates the support of a wide range of roles and activities, through the use of asynchronous conferencing services running over telephone and packet-switched networks. More advanced technologies emulating "presence at a distance", such as videoconferencing, are planned to be implemented in the near future. Such services, integrated with the whole architecture designed by all programmes at GATE: video, computer-assisted learning and telematics, form a whole technology-based architecture which is shown graphically in Figure 5.8.

Step 3.2 - Design of Physical Configuration

- *Network topology (A3.2.1)*

Different access possibilities were designed, in the light of the information on potential users and conditions collated during the modelling process:

- Access through TCP/IP via the UPM-LAN, in the Schools already having it available.
- Access through modem via PSTN, either from home or from Schools (rooms and classrooms).
- Access through PSDN X.25 via LAN, for those actors external to the UPM and running Continuing Education courses.

Figure 5.9 shows the physical topology of the UPM TST system.

- *Configuration of the users' sites (A3.2.2)*

The setting up of the sites was designed as simple as possible, mainly because of the low budget available. A PC or Macintosh linked either to a LAN with IP connection or to a modem and a telephone line was the defined configuration.

Another discussion point was the resources that should be devoted to the installation of users' infrastructure for establishing the connections. What should be the right strategy in this case? Initial considerations were the following:

- At this early stage, it was practically impossible for us to accurately estimate how many teachers would react positively to the system's initiative, and therefore it was difficult to state rules for the users' installation procedure and to estimate the human resources required for

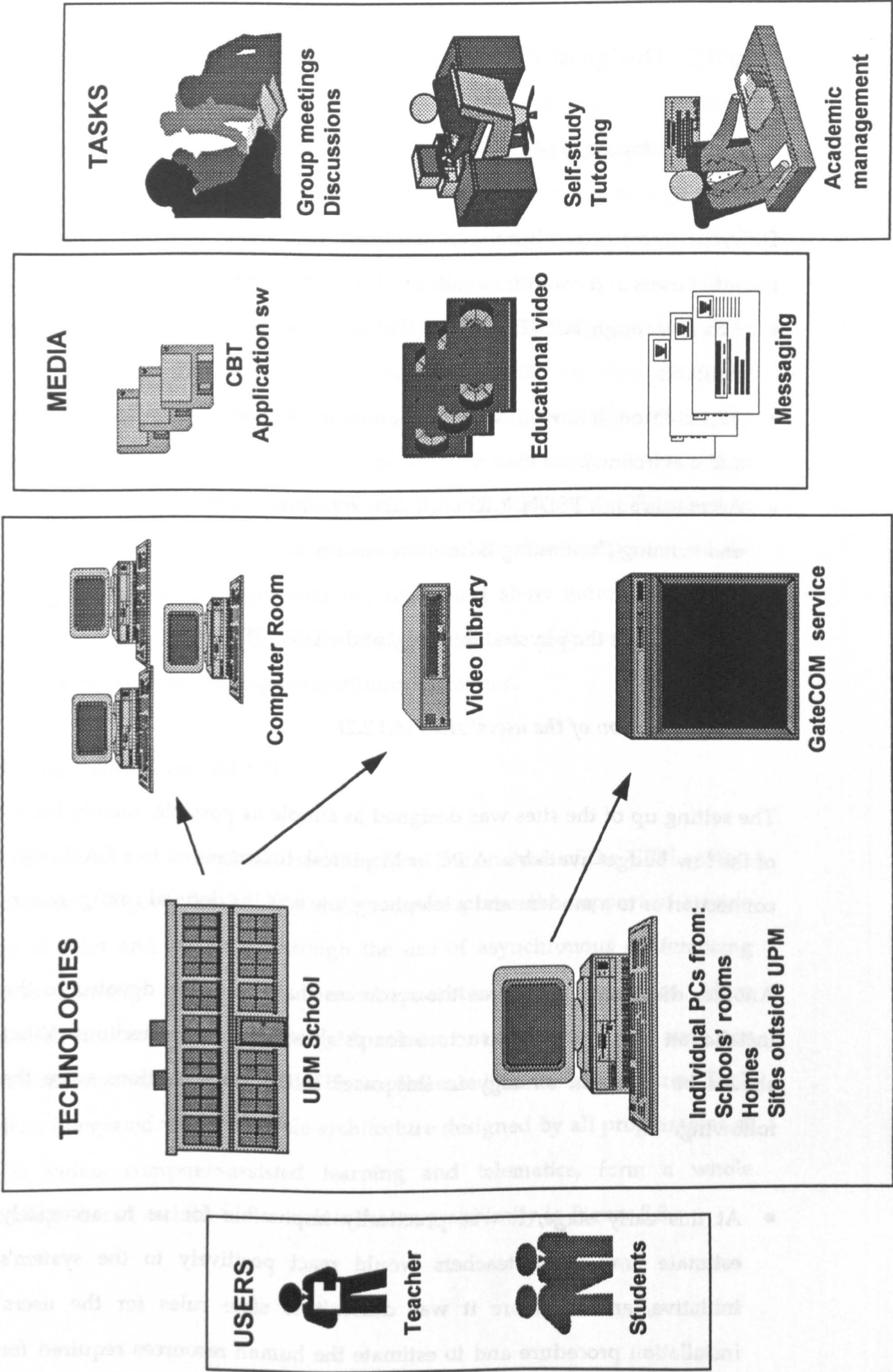


Figure 5.8. Integrated Technology-based Training architecture

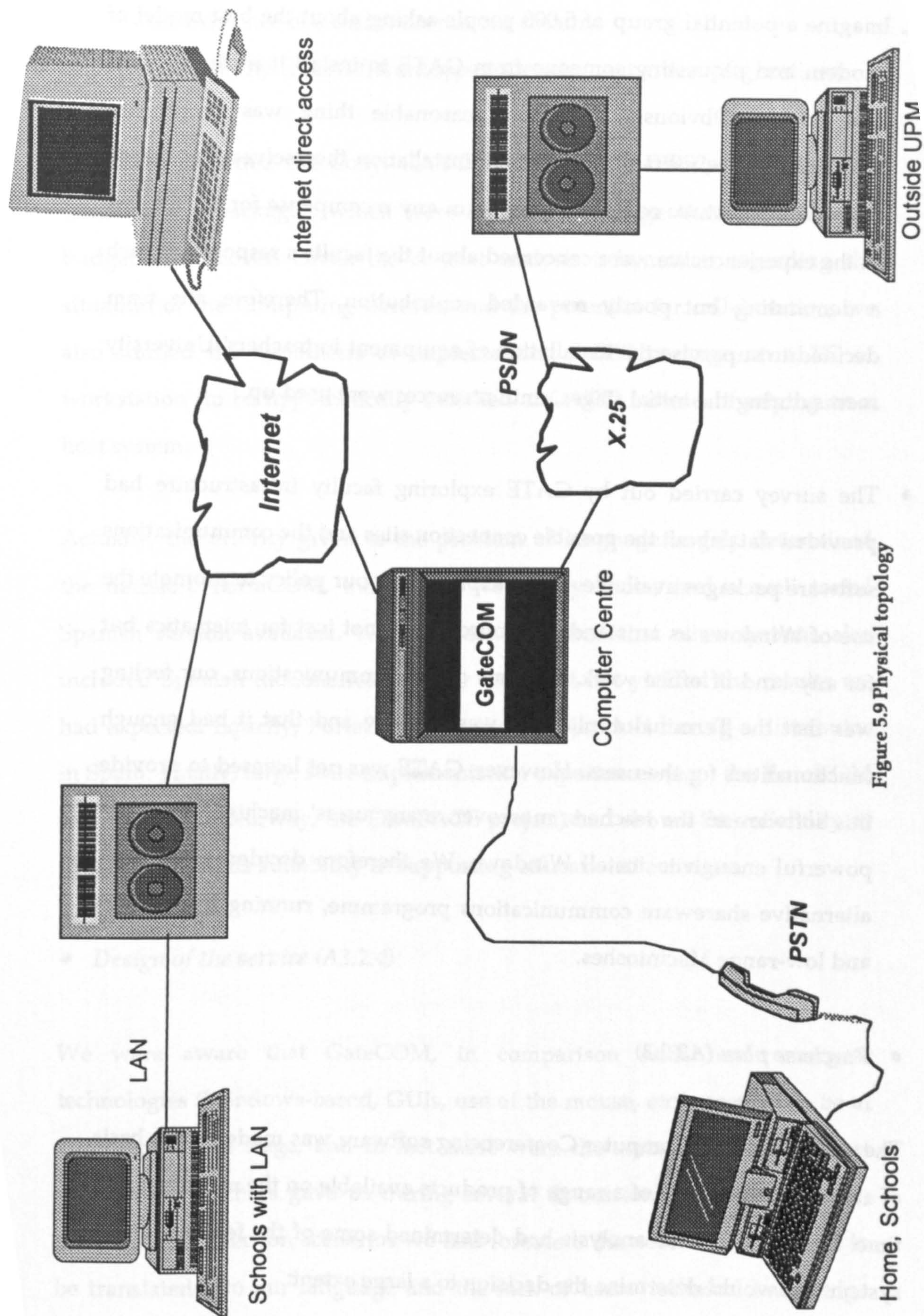


Figure 5.9 Physical topology

it. Imagine a potential group of 5,000 people asking about the best model of modem and requesting someone from GATE to install it in their rooms and houses! Obviously, the most reasonable thing was to prepare materials for the users to perform the installation themselves. But taking into account that we could not offer them any recompense for taking part in the experience, we were concerned about the faculty's response to such a demanding but poorly rewarded contribution. Therefore, the team decided to supervise the installation of equipment in teachers' University rooms during the initial stages, until resources were used up.

- The survey carried out by GATE exploring faculty infrastructure had provided data about the possible connection sites and the communications software packages available. In principle, it was our policy to promote the use of Windows as an standard environment, not just for telematics but for any kind of office work. In terms of telecommunications, our feeling was that the Terminal application was friendly and that it had enough functionalities for the users. However, GATE was not licensed to provide this software to the teachers; moreover, many users' machines were not powerful enough to install Windows. We therefore decided to offer an alternative shareware communications programme, running under DOS and low-range Macintoshes.

- *Purchase plan (A3.2.3)*

The selection of the Computer Conferencing software was made on the basis of a comparative study of a range of products available on the market at that time. The requirements analysis had determined some of the features of the system that would determine the decision to a large extent:

- the language of the interface
- ease in using the system, together with its tested reliability

- the existence of a distributor in our country
- accessibility from different types of equipment and configurations

The study included the CoSy, CAUCUS, PortaCOM, EIES2, and VaxNotes Conferencing packages, which were in the price range that the estimated budget could cover. Given the context analysis information regarding the situation of the Computing Centres, and the potential for collaboration, we also studied the hypothesis of implementing a BBS package on a PC or workstation (to be hypothetically installed at GATE) instead of relying on a host system.

Actually, the priority given to the problem of language largely determined the decision. PortaCOM, the system we finally chose, had a well tested Spanish version available. We had been informed that other systems also included Spanish dictionaries, but our tests had not yielded the results we had expected. Equally, PortaCOM was the only product having a distributor in Spain. Finally, large scale implementation experiences (e.g., the EuroKOM service, NKI in Norway, the EuroPACE project) had shown the reliability of the system, and its suitability in supporting educational activities.

• *Design of the service (A3.2.4)*

We were aware that GateCOM, in comparison with new emergent technologies (Windows-based, GUIs, use of the mouse, etc.), seemed to be at a very primitive stage, and in fact these were the sorts of arguments that some of the teachers gave us during several discussion sessions. However, the kind of connection scenarios we had foreseen, the need for the system to be translated into our language and the lack of users' technical knowledge had forced us to start the experiences with this standard. Moreover, we knew that the plain version of PortaCOM offered limited functionality. Because of a

problem with computer emulations, the system would not accept Spanish characters (¿, ¡, ñ and accents), thus making writing very uncomfortable for users. Along the same lines, it was not possible to edit formulas or technical symbols, and this would possibly hinder the contacts with teachers of these subjects (Maths, Physics, Electronics...), a large group at the UPM. But the limitation that worried us most was the lack of off-line working facilities; this made it very difficult to promote the use of the system while involving students outside the UPM; besides, the service only had one telephone line available, and we predicted that saturation problems would arise as the number of students grew. We did not expect a large volume of access through data networks, since our potential users were not extensively linked to hosts and LANs in their Schools. Equally, it was foreseeable that novice technology users would feel stressed by having to write 'live', especially during the initial stages of the experiences. Besides, having to work on-line usually introduced strange characters, line noises, etc., that in the end might create a poor impression of the quality of the service as a whole. Obviously, users did not distinguish between problems due to the network, the connection to the host, and the system's software, etc. Therefore, a decision was made to start the search for new systems that would cope with off-line connections, and to contact Komunity and EuroKOM in order to study the possibility of licensing our users for the off-line readers they were both developing at a reasonable price on a collaboration basis.

As far as the design of initial conferences within the service was concerned, the following ones were selected:

- *'Presentation of Public Conferences'*, *'Presentation of Private Conferences'* and *'Presentation of Users'* were created by the default of the system, and constituted a sort of small databases that provided users with first-hand information about these issues. The system would ask every user to write

their own presentations, and we advised and encouraged users to do so in order to constitute the 'electronic UPM community'.

- '*Avisos del Sistema*' (System News), a read-only conference providing information about changes in parameters, back-up gaps, new developments and facilities, etc.
- '*Conferencia de Ayuda*' (Help Conference) the on-line equivalent to the user's technical support
- '*Conocer GateCOM*' (Getting to Know GateCOM) was designed as part of the training strategy, as a 'guided tour', for users to practice on-line after the tutorial session
- Finally, a '*Cafeteria*', for informal communication.

Step 3.3 - Design of Adoption Strategies

The design of the strategies for gaining users' acceptance of the system started from the information on the target group of users, who were characterized as:

- not having the required infrastructure ready to utilize the system,
- having a low level of computer education in broad terms,
- not being familiar with the scope of Telematics and its functionalities, and consequently,
- not being aware of how to apply such technology as a support to their professional activities

As a result of this analysis, our design assumed that users would have to learn:

- how to come up with the necessary infrastructure for accessing the system
- how to install the equipment and effectively connect

- the conceptual model underlying electronic communication in general, and a computer conferencing system in particular
- how to effectively navigate through the system (commands, etc.)
- how to modify their working habits if the system were used, in terms of additional effort, new tasks, change of roles, etc.

Bearing these factors in mind, on the one hand, and the predominant tradition of face-to-face communication in the University, on the other, we designed the following adoption strategies.

- *Information level (A3.3.1)*

The objective here was to make as many potential users as possible aware of the creation of the GateCOM service, stating its characteristics at an advertising level. The only technical aspect reflected here was the requirement of a computer and a telephone line for accessing the service. The conceptual model underlying the system was described using the room metaphor for explaining the conference / message structure. Information on how to contact GATE in case of interest was also included here.

- *Induction level (A3.3.2)*

In this case, the aim was for potential users to acquire deeper knowledge of the functionalities of the service and the types of applications that could be useful for every specific academic situation. It was expected that the potential user, once aware of the existence of the service, would approach GATE with a view to exploring the usability of the system, and its usefulness for his/her particular needs. The audience here would range from individual sessions to group-oriented meetings in which specific functionalities of the service could

be discussed, e.g., department meetings to agree on its use for academic management purposes, or sessions convened for Senior Lecturers active in Continuing Education in other Spanish provinces. Finally, an induction activity was planned to inform the potential users in more detail about the support they would receive from GATE on proposing an experience, the conditions for accessing the service (mainly in terms of equipment needs) and the process that would be followed to carry out the experience.

- ***Training level (A3.3.3)***

The target group at this level would be composed of users who have already taken the initiative of using the system. Consequently, the level of knowledge transmitted is much deeper, covering all the aspects described above: how to connect, navigate and new tasks and new behaviours as a result of the use of the system. This type of action should never be taken until users have their infrastructure ready for connections. Larger sessions and small groups were designed in this case, since individual practice with the system was required. Three categories of training were considered, given their qualitatively distinct nature:

- **Training in the use of the system:** revision of functionalities, connection procedures, commands and basic actions with PortaCOM (types of messages and conferences, reading and writing).
- **Training in the pedagogical exploitation of the system:** teaching aspects and how to cope with them through the system like the design of conferences, students' introduction to the course, the commencement and management of discussions, the monitoring of groups and individuals, additional materials required and the adaptation of the existing ones for a given course, etc. To this purpose, a 2-month course was designed to be

run on-line, called "Introduction to Educational Telematics". The course combined 4 face-to-face sessions with 15-day modules of self-study, with a view to making tutors practice as students with the tool in order to discuss about their potentialities on a highly realistic basis.

- **Practice:** The final training level would consist of users practising with the system on their own. To facilitate this process, an on-line conference, 'Getting to Know GateCOM' was designed for guiding the user through the browsing and participation in conferences and oriented to reinforce the familiarization process.
- ***Technical Support (A 3.3.4)***

Special attention was paid to the proper design of support services:

- A telephone hotline for contacting GATE directly about any question, either technical, organizational, educational, etc.
- A conference in GateCOM called 'Help!' for users to leave questions, queries, etc., that would be dealt with by the TelEd team.
- A plan for introducing TelEd team members during the training sessions so that users would recognize them and thus facilitate a more personal contact.

Step 3.4 - Design of Pilot Experiences

- ***Selection of pilot experiences (A3.4.1)***

The selection of pilot experiences had been a matter of discussion from the very beginning of the analysis and design process. The main objective of the pilot experiences was to test the suitability of the architecture for the

context in which it was supposed to operate. However, we were also constrained by the willingness of teachers to run experiences, given the nature of GATE as a service to the UPM faculty. The experiences selected to be run by GateCOM during 1992-93 could therefore be classified in two different categories:

- those coming from the teachers' initiatives, once they had become aware of and familiar with the potentialities of the service
- those that GATE considered strategically relevant for the testing of the design.

Along these lines, the experiences designed were:

1. - A set of Ph.D. courses under the auspices of the Departments of Applied Mathematics and Communications Architecture at the School of Telecommunications and the Faculty of Computer Science. The testing objective in this case was the suitability of the system's design in supporting faculty's postgraduate teaching and tutoring activities.
2. - A discussion Fora with national scope, dealing with Educational Telematics addressing professionals in the field of Technologies and Education in Spain. In this case, the communication dimension of the TST support was tested in terms of acceptance by the users.
3. - An experience in the field of academic management, by the Department of Languages at the UPM. The testing here is oriented towards the management setting, and the corresponding remote meeting facilities, which was also revealed at the Analysis stage as a suitable application scenario

4. - Finally, a group of distance courses to be run by CEPADE with experimental groups of users around the country. Obviously, the suitability of the designed system as a support to Distance Learning was explored in this case.

- *Creation of Project Teams*

Whenever an experience was proposed, a project group was created around it, which involved at least two people from TelEd (a coordinator and a member of the technical support group), the teacher and the person in charge of the evaluation of the experience.

- *Evaluation framework (A3.4.2)*

The evaluation framework aimed at assessing the implementation of the technical architecture and adoption strategies (Information-Installation-Training-Support) in each case, and the effects they have had on users' reactions to and acceptance of the system (actual uses-perceived usability-reasons for non-use-perceived usefulness).

Along the lines of the evaluation principles stated by ADAM, and focusing on users' acceptance, instruments were designed at this point. Given the small samples expected to be involved in the experiences (never more than 80 people, including all types of roles), it was planned the enrichment of assessment data with individual and group in-depth interviews, either by telephone or face-to-face. On the quantitative side, two pools of questionnaires were designed, concerning:

- Users' expectations of the system: usability, usefulness, connection frequency, etc.

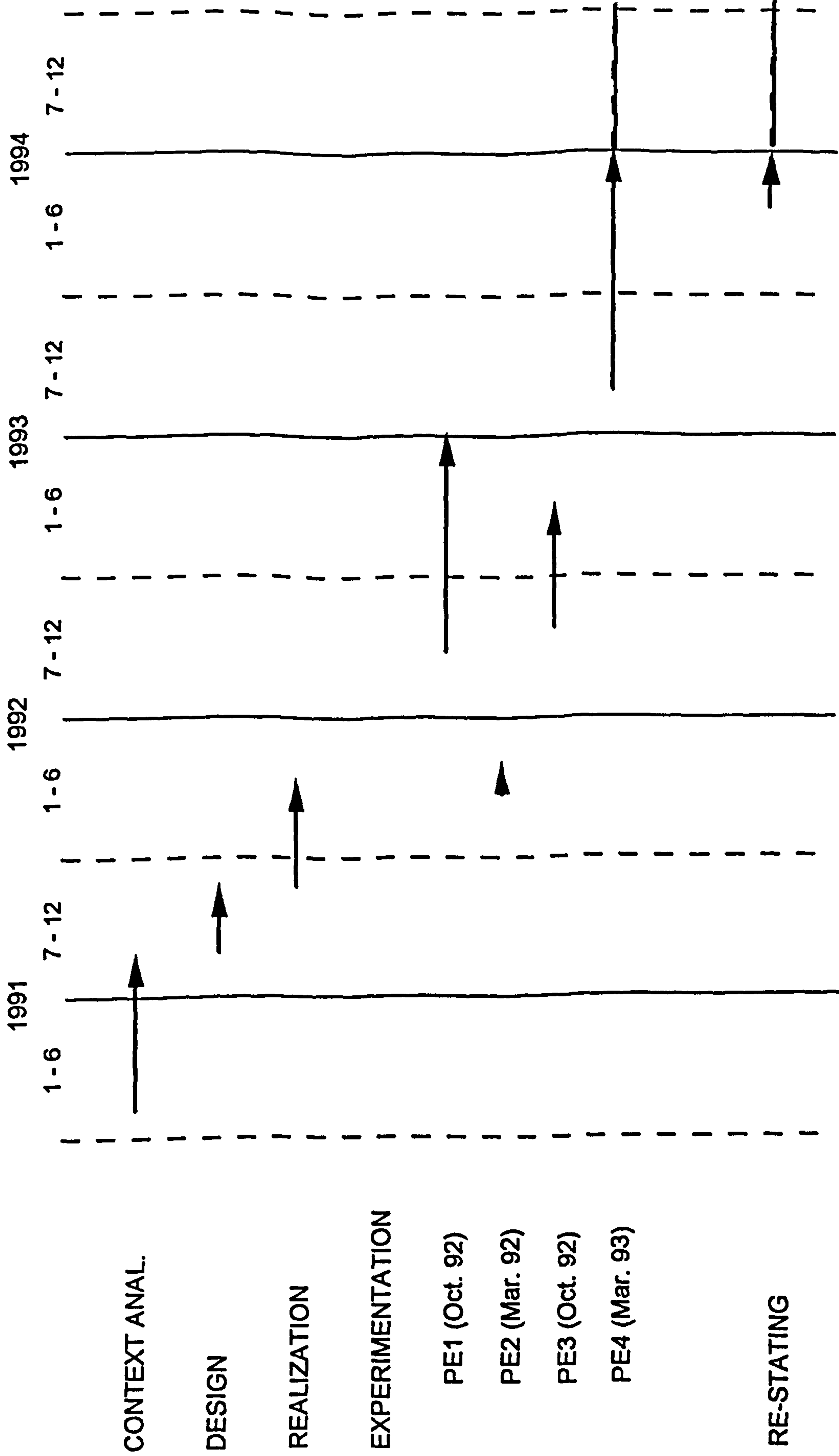


Figure 5.10. Implementation Schedule

- Final evaluation of the previously stated factors, also including actual use of the system, reasons for non-use and the assessment of aspects that could be improved

Drop-out cases would be explored through telephone interviews.

- *Schedule (A3.4.4)*

Figure 5.10 shows the schedule planned for the five experiences designed. As it can be seen, they cover most of the 1992, 1993 and 1994 academic courses.

- *Resources for pilot experiences (A3.4.5)*

The overall strategy concerning the design and planning of pilot experiences was to maximize the use of GATE and UPM telematic resources while minimizing the investments and costs associated with each experience. On the other hand, it has been widely stated that no investment was allowed in users' equipment (PC, modems, etc.). Consequently, once the experiences were promoted, the main concern was to minimize the investment of the individual users; it was clear to us that this factor would be one of the most decisive in assembling teachers and students to run the pilot experiences.

The sort of additional or specific costs considered while designing the experiences are the following:

Concept	Budget
Information and course materials	GATE
Face to face introductory and training sessions	GATE

Support to equipment and software installation	GATE
Telephone charges	UPM or users
Specific personnel (Scholars)	GATE or departments
Evaluation activities	GATE

Outputs of the System Design Stage

- Proposal of the most adequate TST architecture, by filtering alternative solutions through requirements and constraints identified, and cost-benefit considerations.
- A physical design of the TST system to be implemented
- A plan of adoption strategies with a schedule of information and induction activities, together with a collection of training courses for users. The support plan is a result as well.
- A plan of pilot experiences conceived for testing the suitability of the design.

As a result of this stage, a document describing the design of the service and the activities planned was then elaborated and sent to the Rector, who submitted it to the UPM Management Board for the official approval of the programme. A budget was then allocated for the pilot implementation stage of the project in the last months of 1991.

Stage 3 - System Analysis and Design

Key Actions and Results

Step 3.1 - Proposal of Architecture

- **Selected telecommunications services:**
Asynchronous time-bridging systems: e-mail / Computer Conferencing
(supporting problems of coincidence among users as a complement to face-to-face settings)
- **UPM TST Model:**
(see Figure 5.6)
- **UPM TST Architecture:**
(see Figures 5.7-5.8)

Step 3.2 - Design Physical configuration

(see Figure 5.9)

Step 3.3 - Design Adoption strategies:

Information: brochures, initial contacts

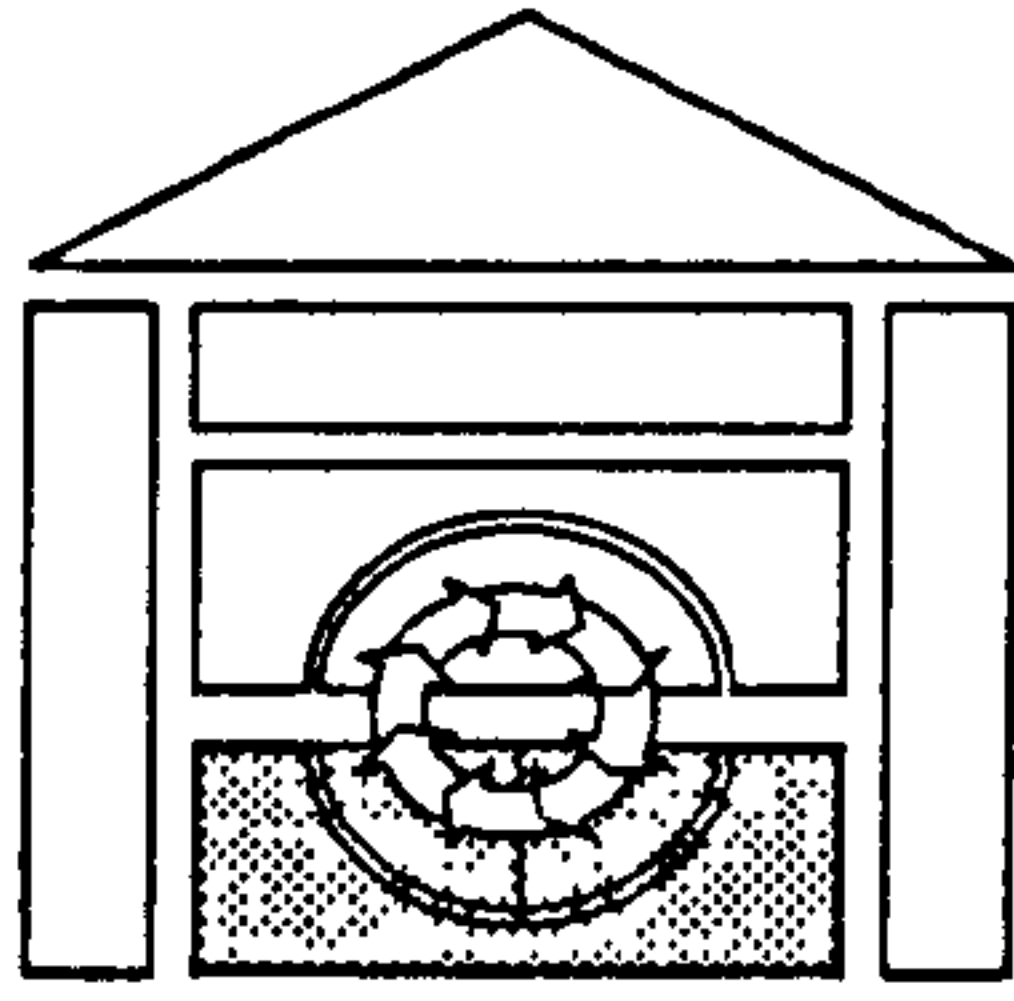
Induction: demos, individual and group meetings

Training: on-line and face-to-face courses

Technical support: telephone and on-line

Step 3.4 - Design Pilot experiences:

- **Select experiences:**
 - 1.- Ph.D. course on Data Communications Architecture
 - 2.- Forum on Educational Telematics
 - 3.- GateCOM as support to Academic Management
 - 4.- GateCOM as a support to Distance Learning
- **Estimate resources**
- **Elaborate schedule**
(see Figure 5.10)



Stage 5.2.4 - TST System Implementation

Step 4.1: Technical Installation

Develop hw / sw
Install hw / sw
Test installation
Set up services



Step 4.2: Setting up of Adoption Strategies

Produce documentation
Prepare sessions
Set up support desk



Step 4.3: Running of Pilot Experiences

Carry out experiences
Monitor experiences
Evaluate experiences



Step 4.4: Re-statement of plan

Draw conclusions
Make decisions on further action

Two sets of activities were begun in parallel, one covering the installation and technical implementation of the TST architecture, and the other the design and development of adoption strategies.

Step 4.1. Technical installation

- *Purchase software (A 4.1.1)*

Permanent contact was established with the distributors, and a contract was negotiated for the purchasing and maintenance of the Spanish version of the system.

- *Hosting the system (A 4.1.2)*

The selection of PortaCOM had turned out to be quite straightforward. By contrast, the decision about the Computing Centre in which the system should run gave rise to a lot of discussion of the following factors:

- type of host and operating system, for PortaCOM was available under many platforms,
- human resources required for technical maintenance
- political and coordination aspects

The final agreement consisted of GATE placing a scholar at the Faculty of Computer Science to run the coordination of the installation and technical maintenance of the system, as a member of GATE's TelEd team. GATE also allocated a budget for the purchasing of a powerful modem for the host, while the Centre allowed access to the Computer Conferencing system through different communication networks. The service would be called GateCOM.

It is relevant to note in this context that the attitude of the Computing Centre towards the system was highly sceptical and not as positive as we would have hoped. PortaCOM was considered an old-fashioned product, and TelEd as a project was regarded with suspicion. Therefore, we were ready to expect only a limited willingness to collaborate with the Centre, and this attitude determined the parameters of the negotiations and the further allocation of tasks and responsibilities between both groups.

- *Technical Installation (A4.1.2)*

The installation of the system was performed quite smoothly, working in close collaboration with the software distributors. Initially, the system's

database was implemented to handle a maximum of 300 users and 200 conferences, and it would accept up to 5 simultaneous connections. GATE hired a 2400 bps X.25 line with 2 virtual channels, and the Computing Centre provided an Internet access and a telephone extension of the UPM Ibercom telephone network that would allow free connection by teachers from their University rooms.

After several demonstration sessions, we had collected a relevant number of claims from teachers missing a file transfer functionality in the system. As PortaCOM did not offer this facility, it was agreed to open a different account on the host, called GATEFICH (GATEFILE), that gave access to a file transfer menu developed under VMS. In spite of the inconvenience of using two separate accesses, some groups of users gladly welcomed the new facility that allowed them to exchange technical texts and graphics electronically.

- *Setting up users' infrastructure (A4.1.2)*

Following the decisions made at the design stage, a search for shareware programmes in Spanish was made with unfruitful results. Consequently, the Telix shareware programme was selected in its original English version, and language problems were compensated through:

- developing a configuration file as complete as possible, for automatically installing the programme, selecting communication parameters and logging in to the host through several macros,
- producing detailed but short documentation explaining to the user the basics of Telix, and
- closely monitoring the users over the phone.

- *Testing activities (A4.1.3)*

A testing period for the system was fixed, in which two persons from GATE made systematic testing both of the connections from the designed scenarios and of the system's operation. Observation logs were elaborated and incidences communicated to the Computing Centre for their mending by the technical staff.

- *Organization of the GateCOM service (A4.1.4)*

Logistics of the service

An important organizational aspect at this point was the coordination of GATE staff with the Computing Centre and the distribution of responsibilities in order to offer an integrated service to users. The TelEd team would receive all the messages from users and channel problems beyond our control to the scholar at the Faculty of Computer Science. Equally, the management of the 'Help!' conference would be performed by the technician at GATE, who would also install modems when necessary. We considered that this task of connecting teachers' equipment was actually more than a technical fact, since users always wanted to spend some time after the installation in trying to connect and in experimenting with the equipment. It would therefore make much more sense for GATE to do this sort of task, taking into account the agreement we had reached with the Computing Centre in term of the division of responsibilities.

On request, users were allocated an account in the system, and a training session was agreed with the TelEd team, once the equipment for connection had been installed and tested. At the session, they were given a letter with the user ID and password, as well as the training guides and supplementary

materials. If they did not attend the training sessions, the guides were sent by mail together with the account identification. Initial sessions with GateCOM were closely monitored, and users were telephoned if they did not connect within a given period, in order to find out about the problem and sort it out.

Creation of initial conference structure

Once the system had been properly installed and tested, the designed set of conferences was created to offer a basic service to newcomers.

Once implemented, the service offered a look to the users which is shown in Figure 5.11.

Servicio GateCOM

Este servicio de Conferencia Electronica esta orientado a la realizacion de experiencias educativas con soporte telematico en el ambito de la U.P.M.

Para mas informacion contactar con:

Gabinete para la Aplicacion de las Tecnologias a la Educacion (GATE)
Rectorado U.P.M.
Tel: 336 61 57 Fax: 336 61 73

Bienvenido al sistema GateCOM (1.17G)!
Por favor, indique su nombre completo.
- usu gate

Usuario GATE
De su clave de acceso: -

Tiene 1 carta sin leer
Esta en su buzón.

Que desea hacer? (Leer) siguiente carta, (Consultar conferencias) activas, (Hacerse) miembro (de), Esperar (novedades), (Escribir) carta (a), Salir, Otros.

- salir
Salir

Adios!
GATECOM se despidio 18:01:09.88 de 29-MAY-1994

Figure 5.11. The user interface in GateCOM

- *Installation maintenance and support (A4.1.5)*

The technical maintenance would be held by the technical staff at the Computing Centre. In those cases where users reported problems concerning the system's implementation, GATE would collect and transmit them.

Step 4.2 - Setting up of Adoption Strategies

- *Documentation (A4.2.1)*

As was stated at the activity A3.3.1 of the design stage, the objective of information strategies was to make as many potential users as possible aware of the creation of the GateCOM service. Brochures about GateCOM and a short document explaining what is a Computer Conferencing system were produced and sent to potential users under this level.

- *Induction sessions (A4.2.2)*

Also following the design, deliverables produced at this level included, as well as the many induction sessions carried out (more than 60 in one year), a demo diskette with a simulation of a navigation session in PortaCOM (produced with the Show Partner presentation package), an Annotated Bibliography of Educational Computer Conferencing Applications, and a collection of papers covering aspect of use of these systems that were of interest to the audience in each case. Overheads were produced addressing every particular audience, in order to design tailor-made sessions for every specific group.

- ***Training sessions (A4.2.2)***

Deliverables produced at this level were the following:

- ***Training in the use of the system:*** a detailed user guide, including a map of PortaCOM commands and 'electronic ethical rules' was produced to support this stage. A short guide including tips and shortcuts for the basic actions in GateCOM was also drawn up.
- ***Training in the pedagogical exploitation of the system:*** users received a 'On-line Tutoring Guide' describing the process to be followed in running an educational experience, with examples of messages and strategies, an estimation of the time and effort to be devoted to each of the stages, students' requirements, etc. Also as had been designed, the course "Introduction to Educational Telematics" was set up, in collaboration with the Institute of Educational Sciences, responsible for the in-service training of the faculty.
- ***Practice:*** The on-line conference, 'Getting to Know GateCOM' was created. It was composed of 16 messages written by GATE's System Administrator, guiding the user through browsing and participation in conferences, providing instructions and proposing exercises for speeding up and reinforcing the familiarization process. Each message referred to the corresponding pages of the User Guide, and adopted a very action-oriented approach to the learning process.

- *Users' support desk (A4.2.3)*

The support services designed (A 3.3.4) were set up and users were informed of the different possibilities of obtaining support they had during the running of the experiences.

Step 4.3 - Running of Pilot Experiences

- *Running of Pilot Experiences (A4.3.1; A4.3.2; A4.3.3)*

For the sake of clarity, the complete activities of realization, monitoring and evaluation included in this ADAM step will be described for every particular experience.

PE1. Pilot Experience 1: A Ph.D. seminar on Data Communications Architecture

As a result of one of the demonstration sessions carried out by the TelEd team, in this case addressing the system application potential in postgraduate training scenarios, a teacher from the Faculty of Computer Science approached us with the intention of experimentally operating one of his Ph.D. courses on 'Data Communications Architecture' with the support of the service.

One of the main problems of the Ph.D. courses is the low level of attendance at the classes (usually 2-hour weekly sessions), lower than 40 % and with different students every time. It is therefore very difficult for the teacher to run the course smoothly, since students have to catch up with the contents discussed in previous weeks.

In order to overcome this problem, the teacher considered the interesting possibility of uploading the material for every session (papers and overheads) at GateCOM in a file format. Students would then be able to access materials, have discussions with the teacher and peers, and therefore work through the contents of the classes.

PE1.1 Objectives

- To establish a permanent communication channel for students to be able to catch up with course dynamics in case they would miss face-to-face sessions
- To increase the tutoring effectiveness by not depending on fixed timetables for interaction.

PE1.2 The students

A group of 20 students participated in the experience. Given their background (they are all graduates at the Faculty of Computer Science and the School of Telecommunications) and the course subject, learners did not expect major navigation problems, either with GateCOM or with the file transfer facility. They had all used other messaging systems, and in this sense, they all equally expected (from the information collected during the demonstration session) that the software would have deficiencies in the editing and file transfer functions. Two comments from students during the session illustrate this point:

"As a complement to classes, I think it is a good idea in that it helps people to work and study at the same time. However, I don't think it can compare with face-to-face sessions, which are much richer and complete."

"As far as I have seen at the demonstration, other systems (News, UUCP) would have been more suitable and standard."

PE1.3 Installation and technical support

Given their professional profile, learners had the availability of computers and access to the service through different networks.

The technical support team did not receive any call about installation or access problems. Several questions explored the functionalities of the system; learners missed sophisticated functions they had been using in other systems (such as X.400 messaging, UNIX News, etc.). The high technical level of teachers and learners made the process run quickly and smoothly.

PE1.4 Training

Apart from the demonstration session, users did not require any sort of training in order to get to grips with the system. They all got used to both the conferencing and to the file transfer facilities in a short time.

PE1.5 Design and moderation of conferences

The TelEd team held several discussions with the course tutor about the teaching methodology to be used in GateCOM. We gave him a Tutor's Guide and tried to make him create a real 'on-line course'. But the tutor's approach was more restrictive as to the use of the system; he wanted it to be limited to a medium of exchange of materials with the group, and ultimately a means of communication to sort out specific issues. For these purposes, two conferences were created: 'Teledoc Board' (read-only), for news and administrative issues, and 'Teledoc Classroom', where references to the

materials and the names and addresses of files were left for learners to download them to their computers.

PE1.6 Results

Participation in conferences

The degree of telematic involvement by the group followed the guidelines the tutor had established: instructions about the sessions, dates and times, together with references to files to be transferred, isolated questions and answers, etc. Learners stayed interactive to a certain extent, but in general the number and content of messages was poor from a pedagogical point of view. Table 5.5 shows the degree of participation in both conferences.

Conference Teledoc Classroom	
Nb. messages by students - 12 Nb. messages by tutor - 5	Topics covered: - Changes in timetable - 41 % - Tutor's outline of the classes - 18 % - Students' reactions to outline - 18 % - Problems with file transfer - 23 %
Conference Teledoc Board (read-only)	
Nb. messages by students - 0 Nb. messages by tutor - 12	Topics covered: - Changes in timetable - 42 % - Corresp. class material / filename 42 % - Others - 16 %

Table 5.5 - Pilot experience 1: Ph.D. course - Participation in conferences

Figure 5.12 - Students participated on-line mainly reading messages, not only in the conferences on their course but also in other public ones, where they have contributed very few messages as well.

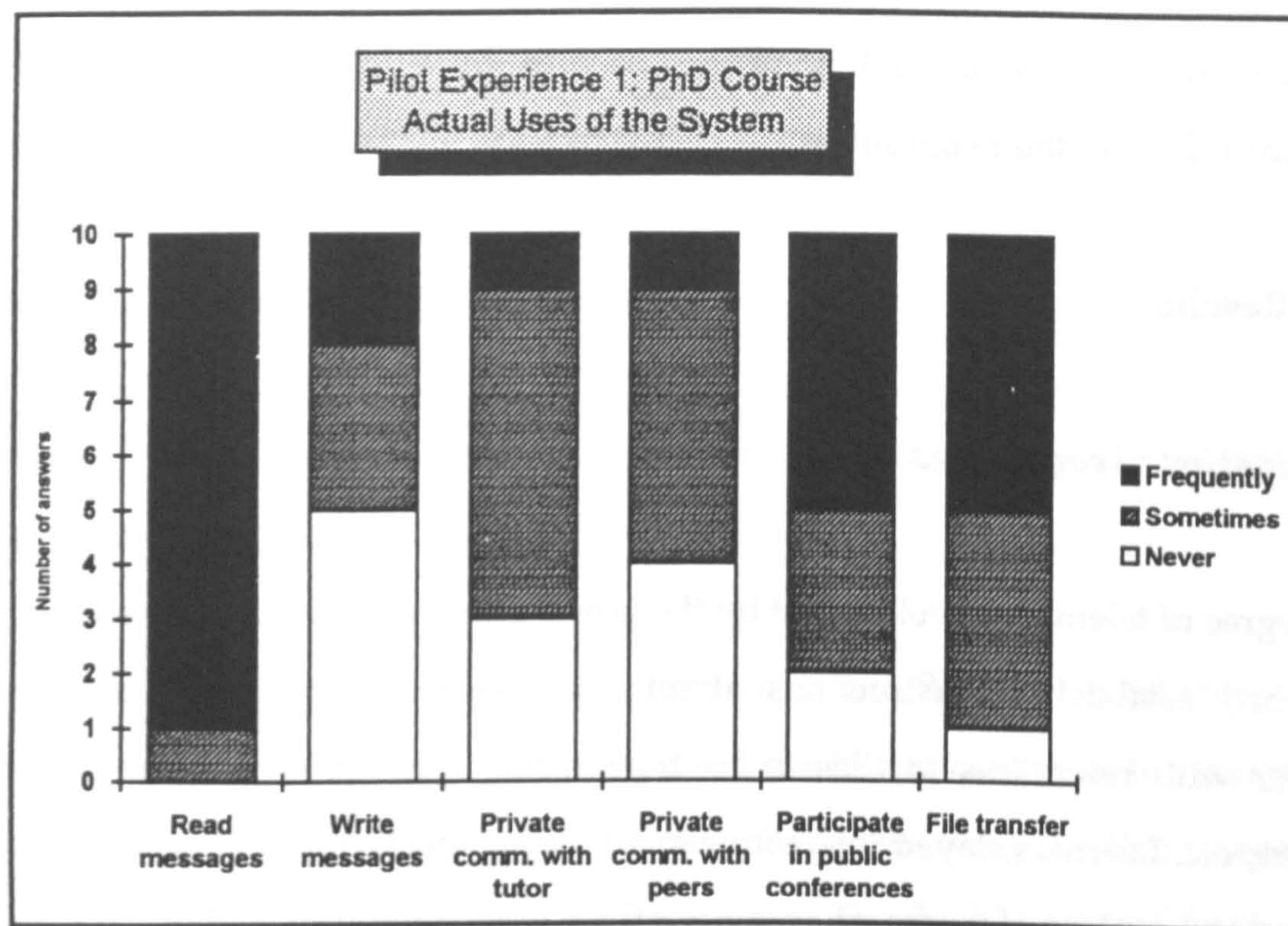


Figure 5.12 - PE1: Actual uses of the system

Perceived usability

As expected, the system was considered easy to use by 100 % of the users. The most important factor affecting usability was the absence of functionalities in GateCOM in comparison with other (technologically 'brighter') systems that learners had used for other purposes, for example flexibility in the file transfer facility.

Perceived usefulness

Figure 5.13 - The improvement in the accessibility to the materials has been considered the most relevant factor in terms of usefulness, precisely the main objective of the experience. Nevertheless, it is recognized the advantage of the medium in maintaining the sense of integration in the course and the link with the tutor.

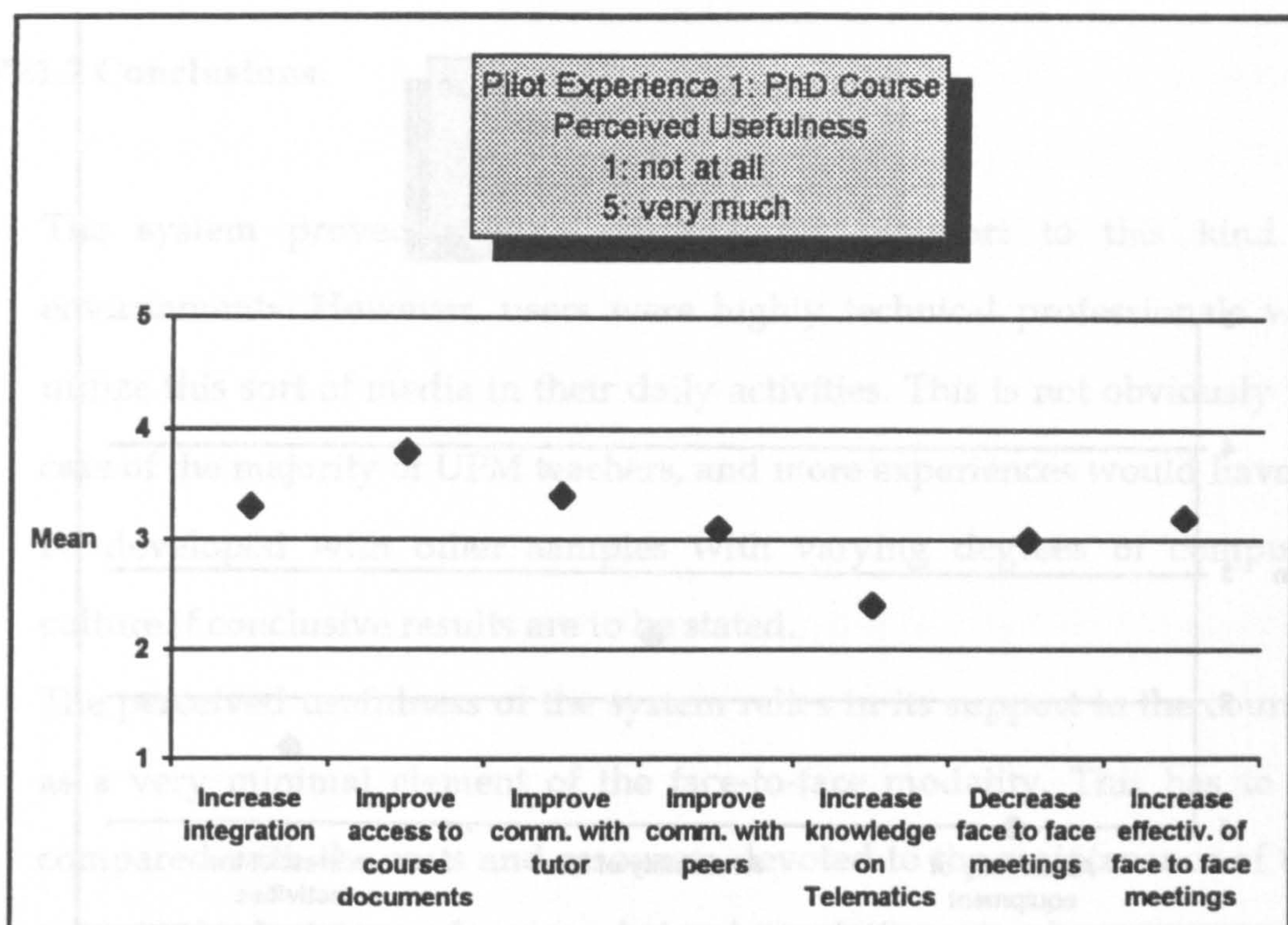


Figure 5.13 - PE1: Perceived usefulness of the service as a support to the course

Reasons for non-use

The lack of time has been the most common reason for non-use; however, learners have connected to the system quite regularly and no severe limitations were reported.

Improvements to the system

According to the statements made by learners during the initial stages of the course, their perception was that, though the telematic media in general was very adequate to their needs and the experience was considered a success, PortaCOM was too restrictive and 'primitive' to be used:

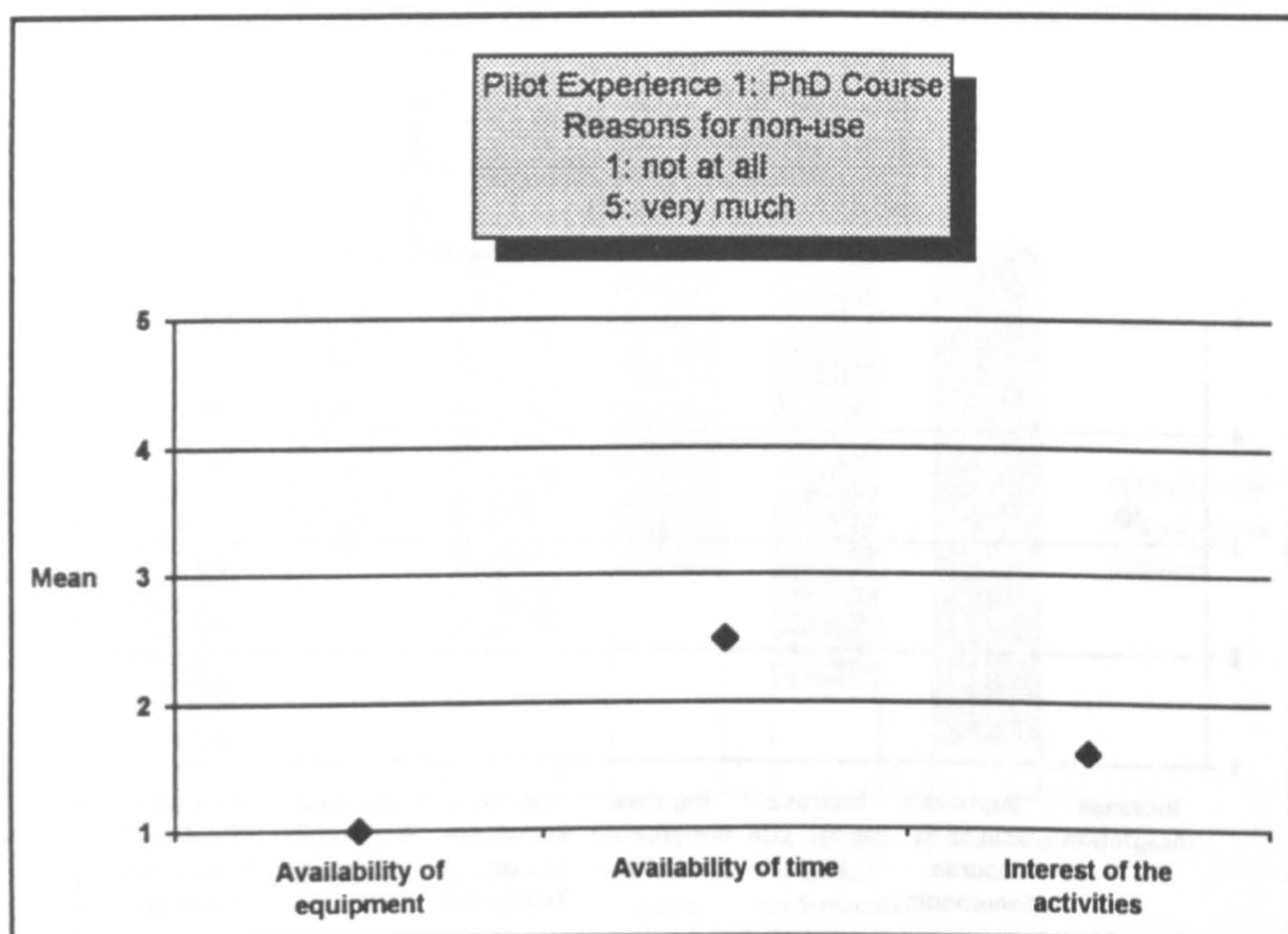


Figure 5.14 - PE1: Reasons for non-use of the service

"The tool is quite dull regarding the management of messages (...), though the most negative aspect is the text editor. Many of the e-mail systems I've tried so far already incorporate better functionalities."

"The user interface is very poor; in spite of this, I consider the experience highly interesting and useful"

"I think the GateCOM application is very inferior to the UNIX News service. I can't understand why we don't use this service instead. On the other hand, I consider it an interesting initiative to promote the use of these tools within the University."

"A de-centralized communications architecture would have been more suitable to this application."

Overall, the experience was considered by 90 % of the students as 'good-excellent'. As for the tutor, he is currently repeating the same course design during the current academic year, with an increased number of students.

PE1.7 Conclusions

- The system proved suitable in providing support to this kind of environments. However, users were highly technical professionals who utilize this sort of media in their daily activities. This is not obviously the case of the majority of UPM teachers, and more experiences would have to be developed with other samples with varying degrees of computer culture if conclusive results are to be stated.
- The perceived usefulness of the system relies in its support to the courses as a very minimal element of the face-to-face modality. This has to be compared with the costs and resources devoted to the maintenance of the system, if a decision on larger scale implementation is made.
- Adoption Strategies did not play a relevant role in this case, given the high degree of expertise of the participants. Conversely, the lack of "technological brightness" of the system played against acceptance, as was expected from this sort of user.

PE2. Pilot Experience 2: Forum on Educational Telematics

During the months from April to July 1992, a Discussion Forum on Educational Telematics was developed through the GateCOM service, sponsored by GATE. It was oriented to offering hands-on experience with a telematic media, at the same time that a debate is running about the suitability of such systems and the problems they might pose in educational scenarios.

PE2.1 Objectives

- To create an atmosphere of discussion involving relevant users and decision makers in the field of Educational Telematics and exchange experiences and opinions about the application of electronic communication technologies to their different training and educational settings.
- To make participants effectively use a Computer Conferencing system (very similar to the one they could implement in their own organizations) for a period and express their opinions and ideas about their experience.
- To test the potential of the GateCOM service as a conversational tool in supporting distant working groups around subject-oriented discussions.

PE2.2 Information

GATE sent a letter of invitation explaining the rationale of the Forum, together with a brief questionnaire to be faxed back to GATE if interested in participating. The form included the updating of contact information and some questions about their connection scenarios.

The initiative was welcomed with great enthusiasm by the majority who expressed their interest in such an event and the need for information about the topic to be promoted on a wider scale.

PE2.3 Participants

In response to the initial 62 invitations, 54 people from 24 institutions (15 out of them from the UPM) expressed their interest in participating in the discussion by faxing back their completed forms. In spite of their reported infrastructure, not everybody necessarily had previous experiences with

telematics. Around 30% of the participants either worked in the field of Education (both face-to-face and distance), or fulfilled high managerial roles in their organizations, and therefore had little hands-on practice with e-mail or computer conferencing.

PE2.4 Training

Given the diverse characteristics of the participants, we decided to perform training in the use of the system in a highly flexible way, offering the choice to:

- run the learning on their own, following the 'Getting to Know GateCOM' conference, through which they would easily get to grips with the process of reading, writing and navigating using basic commands, and working through the demonstration diskette and user's guide,
- have an initial face-to-face session at GATE for initial tutored practice
- ask for a TelEd team member to go to their work place and have a private tutorial session (in the cases of participants from Madrid with special timetable problems)

PE 2.5 Installation and Technical support

Given their professional background, all of the users were expected to have the minimum infrastructure to establish the connections, as well as some degree of technical support; in spite of this, the TelEd team offered its hot-line service, which was quite frequently used during the first few weeks of the project.

Two members of the TelEd team ran the technical support to users during the initial stages of the process. They were responsible for selecting and sending

out the documentation to the users (once they had expressed their interest in logging into the Forum discussions), and attending the hotline as problems arose.

Figure 5.15 - As expected, participants had good facilities for connection from their institutions, even from their own rooms. Some of them could access GateCOM through the three possibilities, but the most common way was a modem and PSTN access.

The technical support group received a total of 22 calls during the first three weeks, mainly because of line saturation problems and questions about the system's functionalities (file transfer, off-line work, etc.).

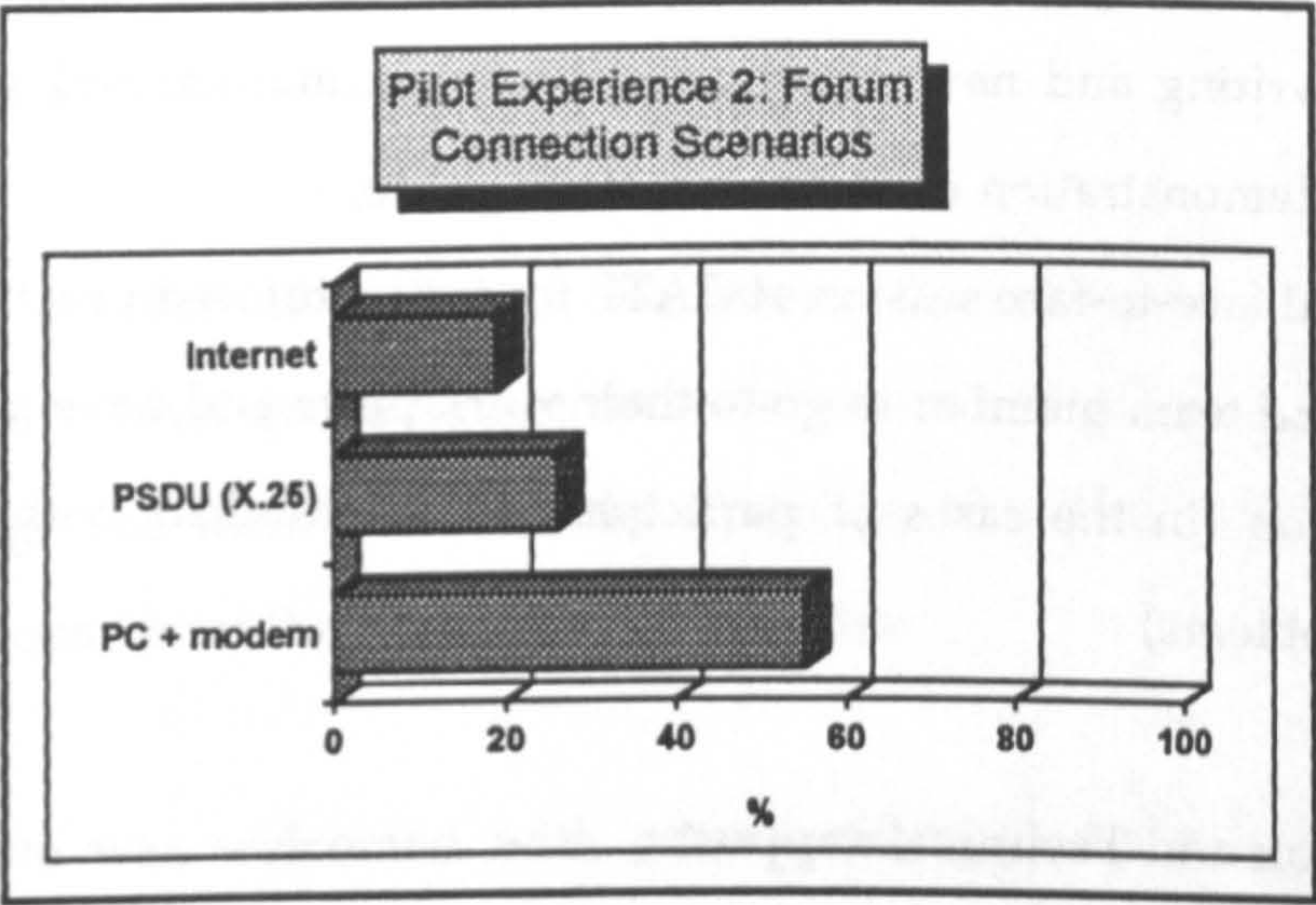


Figure 5.15 - PE2: How the users connected to GateCOM

PE 2.6 Design and moderation of conferences

The Forum was moderated by two members of GATE, the Deputy Director and the author of this work as Coordinator of the TelEd project.

The design of conferences took into consideration the period of practice that users would have to complete by initially creating 'Forum Lobby'. This

conference would act as the 'main entrance' to the discussion, and we asked people to go in there as they logged in for the first time, just confirming their access and identifying themselves. The *'Forum Meeting'* would contain the main discussions on the topics. Two read-only conferences were created as a complement to information : *'Forum News'*, in which general information (newcomers every week, closing dates for conferences, etc.) was fed, and *'Forum Library'*, which acted as a database of literature references and short papers that both GATE and some of the participants contributed as specific subjects arose in the discussion.

PE 2.7 Results

Participation in conferences

Of the 54 people who had confirmed their intention of participating, 38 actually accessed the conferences, and another 4 only logged once in the first week.

Conference	Messages	Participants reading messages	Participants writing messages
<i>Forum News (*)</i>	7	34	—
<i>Forum Discussion</i>	80	33	18
<i>Forum Lobby</i>	42	32	13
<i>Forum Library (*)</i>	8	24	—
<i>Cafeteria</i>		15	10
<i>Presentation of Users</i>		7	14

(*) Indicates read-only conferences

Table 5.6 - PE2: Participation in the Forum Conferences

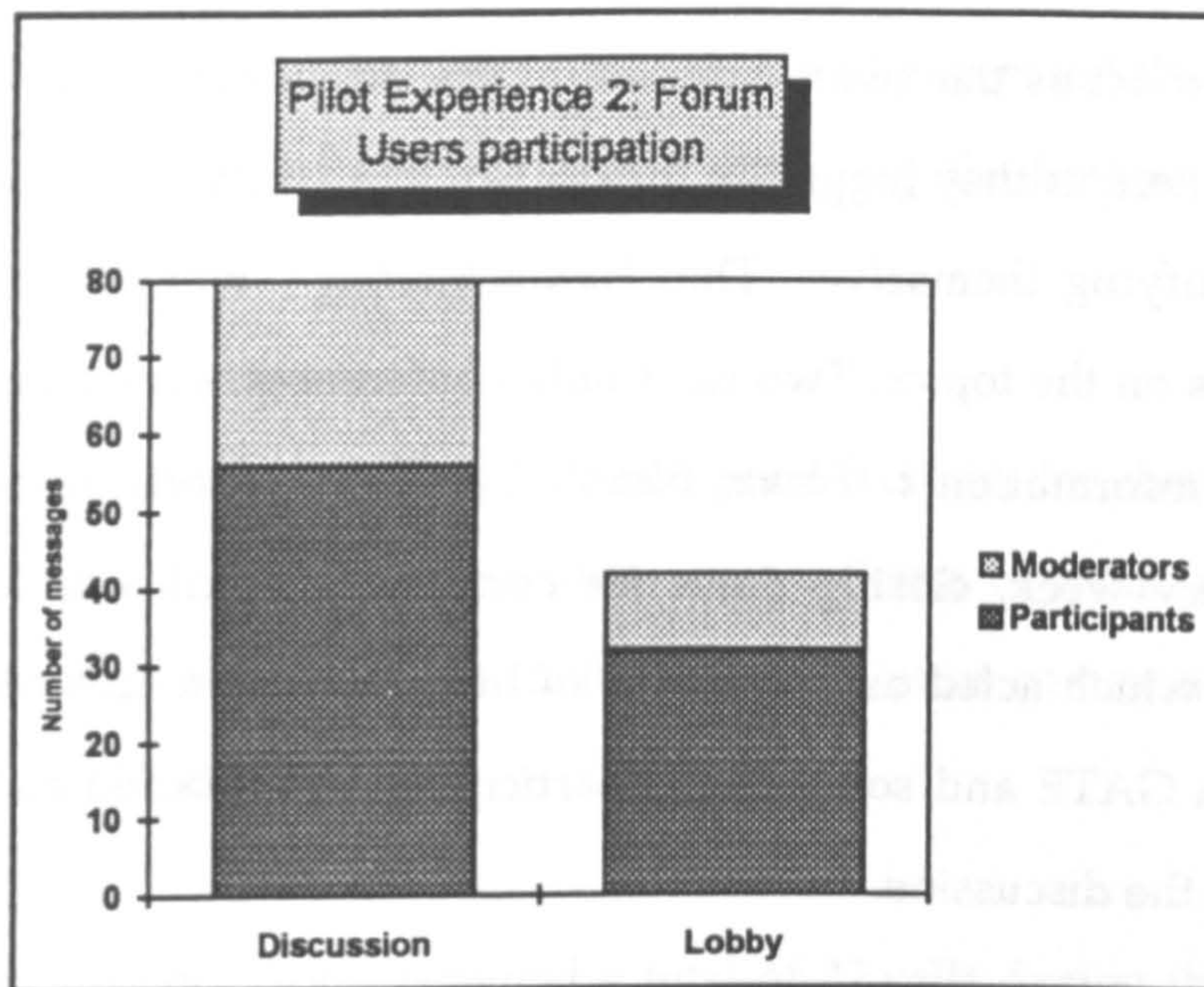


Figure 5.16 - PE2: Comparative contributions of moderators / participants

Tables 5.6, 5.7 and Figure 5.16 - From a quantitative point of view, again bearing in mind the characteristics of the group, the number of participants' messages written in the conference discussion was considered a good rate. Equally, the quality of the interactions reached a high standard, both in terms of the number of topics that arose, and on the level of statements and conclusions about some of them. These data are positive indicators of the quality of the participation, and above all of the degree of adoption of the system, which by no means has hindered thoughtful discussion.

Perceived Usability

Figure 5.17 - The high degree of familiarity with technologies meant that several participants did not follow the 'Getting to Know GateCOM' conference, and that the User Guide was considered more useful than any other support.

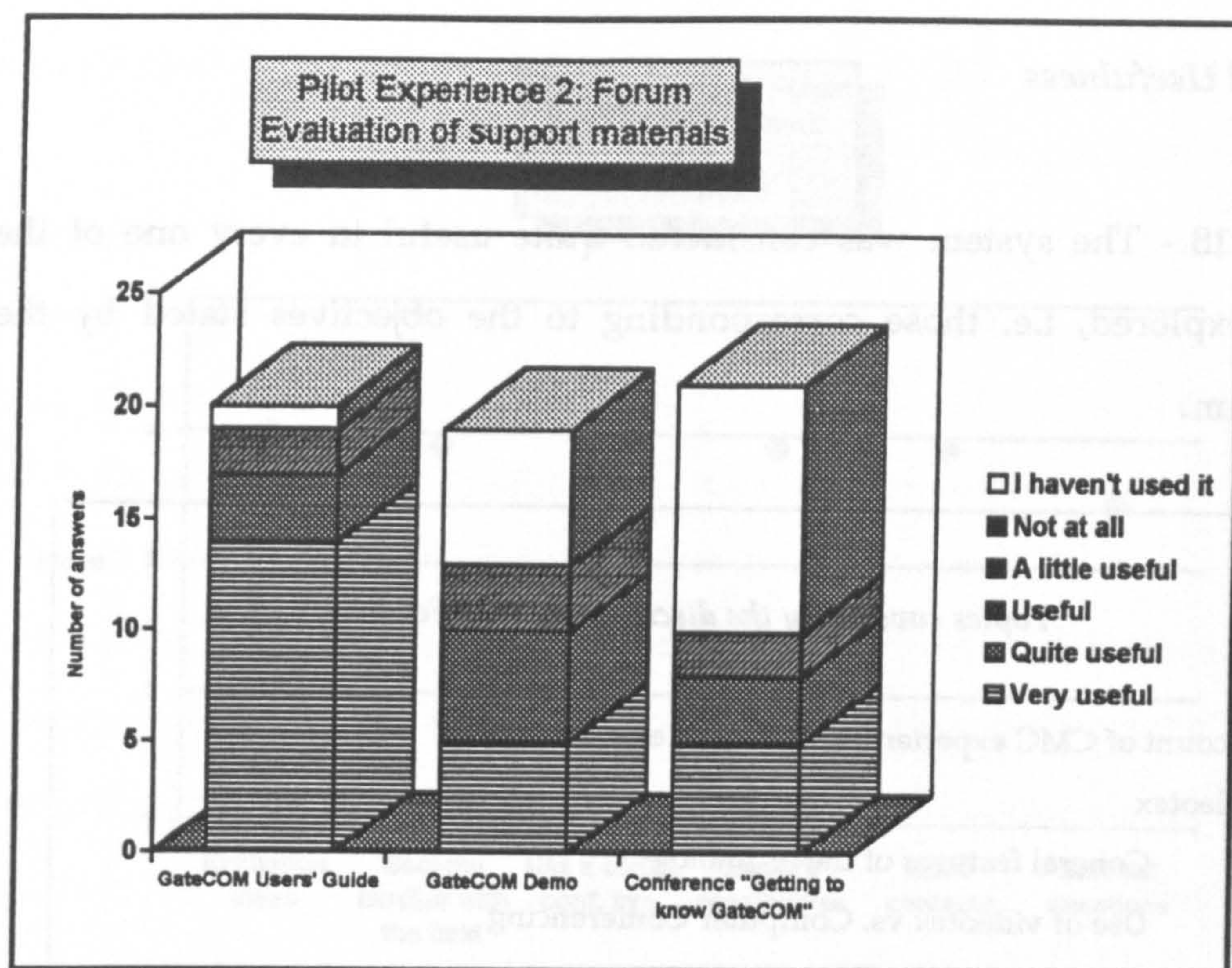


Figure 5.17 - PE2: Users' evaluation of support materials

The messages at the conference 'Forum Lobby' did not show usability problems either; all the messages were correctly written and formatted, and many users attributed the ease of use to the clarity of instructions about the system:

'I've arrived very easily, the path is clearly indicated in the materials. Congratulations!'

'Instructions were clear and precise'

'I want to congratulate GATE on the clear documentation in terms of access and use!'

'I had very few problems in accessing (it would have been much easier if I had read the User Guide before!!)'

Perceived Usefulness

Figure 5.18 - The system was considered quite useful in every one of the aspects explored, i.e. those corresponding to the objectives stated by the TelEd team.

<i>Topics covered by the discussion on the Forum</i>
Account of CMC experiences in Europe and US
Videotex
General features of the technology
Use of videotex vs. Computer Conferencing
Description of Prodigy service
Difference with Teletext
Minitel, description visit to CNED in France
CC systems and products currently in widespread use
(PortaCOM, CoSy, CAUCUS)
Multimedia messaging - X.400 standard
Telematics applications in management (EuroKOM, Univ. of Guelph)
Description of the DELTA CO-Learn project
Telephone charges and their effect on participation
Description of the DELTA project Multimedia Teleschool
Terminology and definitions (in contrast with those of the moderators)

Table 5.7 - PE2: Topics covered in the conference Forum Discussion

Reasons for non-use

Figure 5.19 - As was expected, users blamed a lack of time as the main limiting factor in their participation. One of them referred to it as 'business harassment'. Other factors were also reported to a lesser extent, the permanent availability of equipment and the failure to focus on their interests.

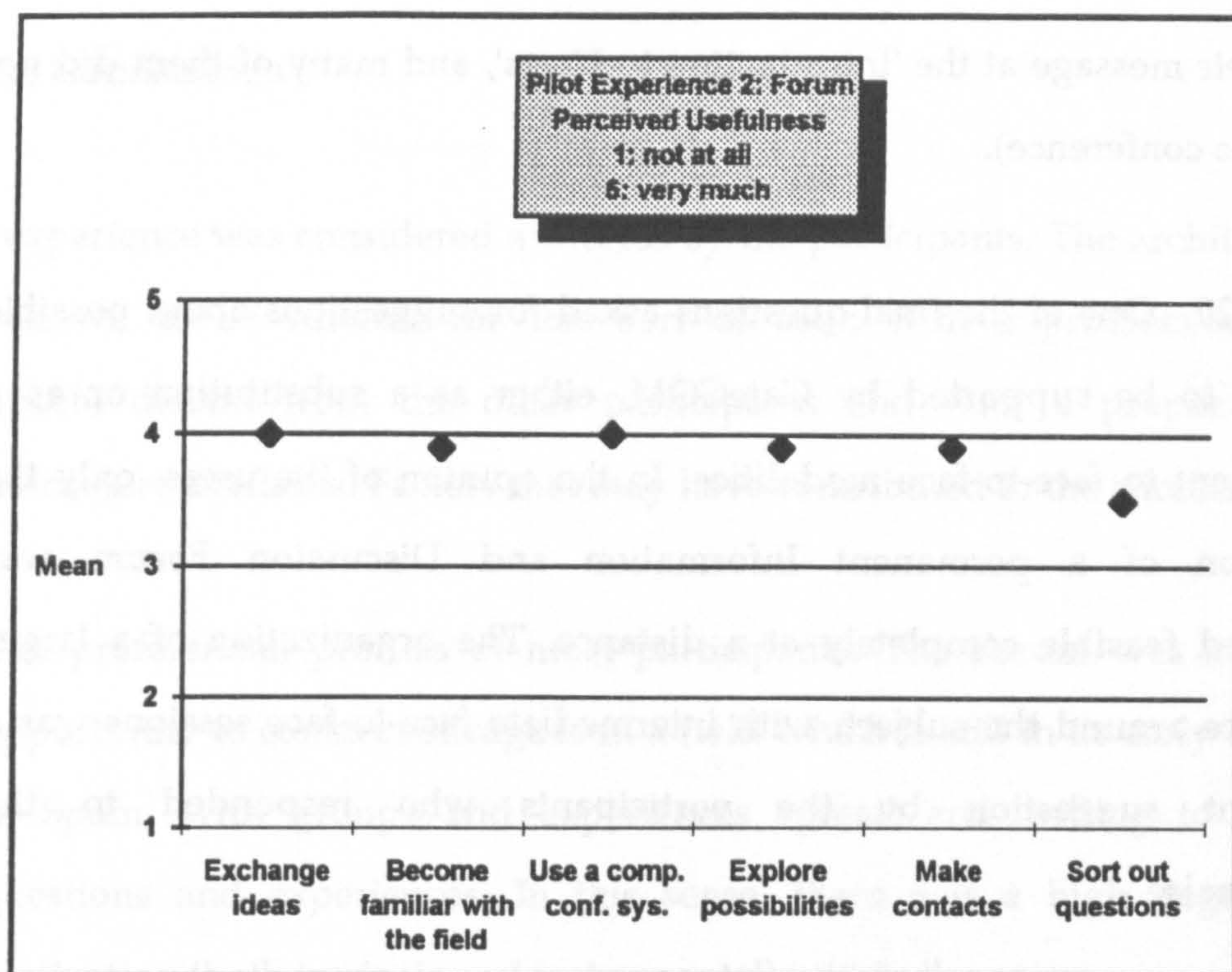


Figure 5.18 - PE2: Perception of usefulness of the system

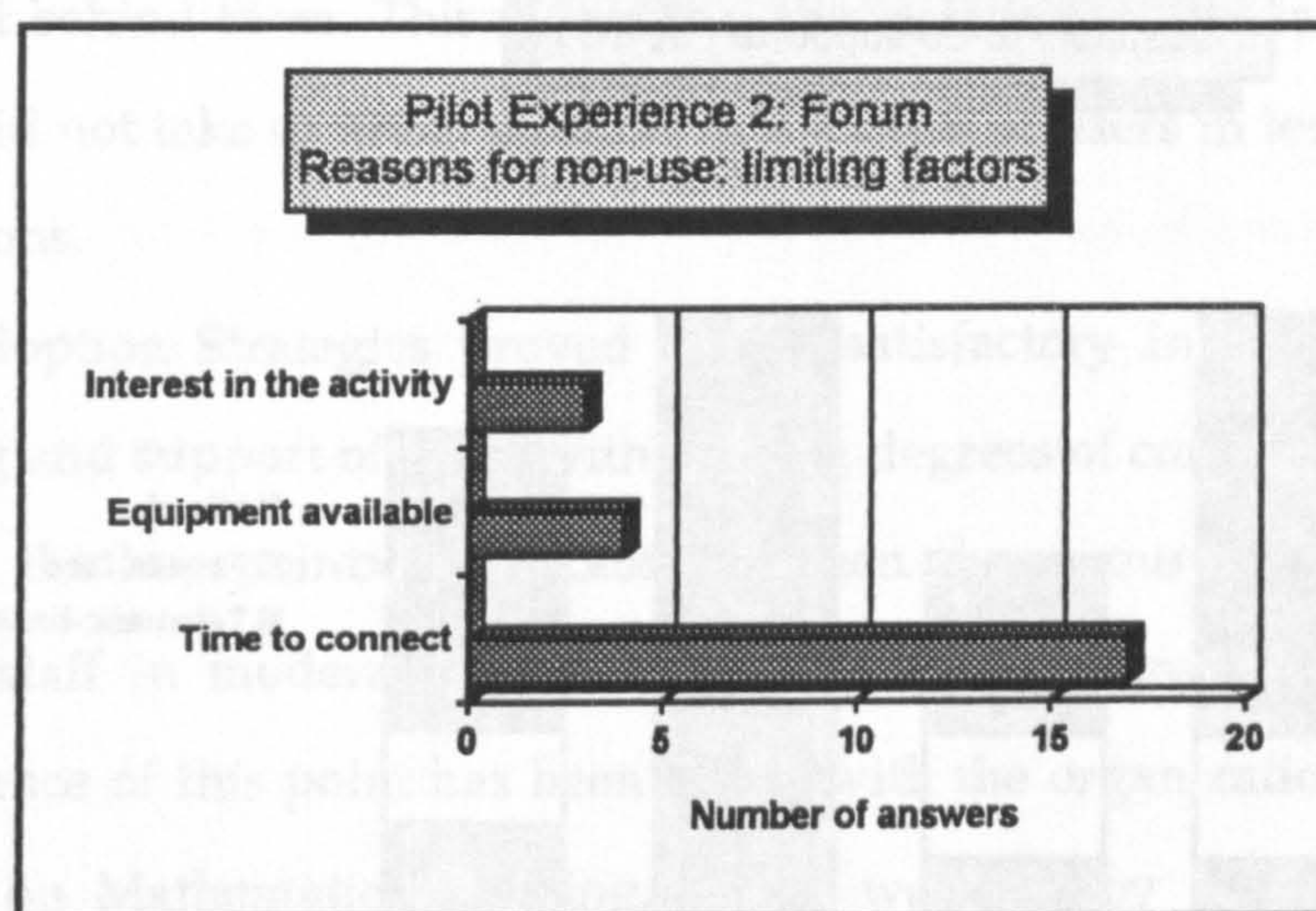


Figure 5.19 - PE2: Reported reasons for not connecting to GateCOM

Improvement factors

Aspects reported by the users as mainly concerned the need for initial face-to-face contacts to create a better feeling of group cohesion. A brief description of all the participants was also considered important (because not all of them

wrote their message at the 'Introduction to Users', and many of them did not access this conference).

Figure 5.20 - One of the final questions asked for suggestions about possible activities to be supported by GateCOM, either as a substitution or as a complement to face-to-face modalities. In the opinion of the users, only the application of a permanent Information and Discussion Forum was considered feasible completely at a distance. The organization of a larger conference around the subject, with intermediate face-to-face sessions was a prominent suggestion by the participants who responded to the questionnaire.

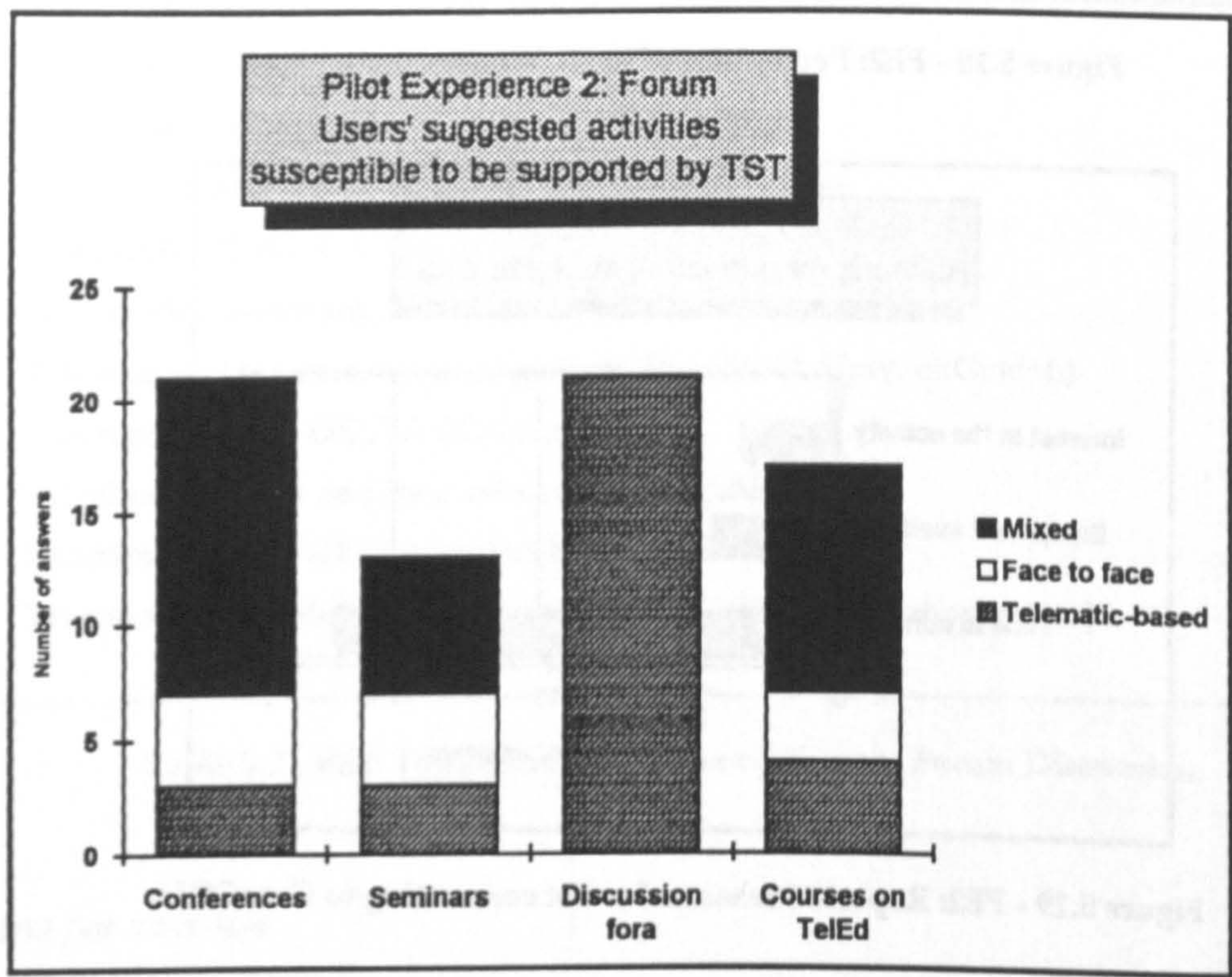


Figure 5.20 - PE2: Suggestions for further activities and modalities of use

It is important to remark that 95 % of those questioned stated in the final questionnaire that their expectations had been met.

PE 2.8 Conclusions

The experience was considered a success by the participants. The architecture has shown to be suitable for this sort of user: with a problem-solving approach, distant from the other participants and with a proper basic infrastructure available. Factors that may have contributed to the success are:

- The professional profiles of most participants. The Forum was a great opportunity to contact colleagues in a field which is still in its early stages in Spain, with groups and experiences spread and willing to share questions and experiences. In this sense, there was a high degree of motivation (both intrinsic and instrumental) within the group.
- All the participants had either a good technical level, or effective technical support behind them. This meant that the installation and familiarization stage did not take so much effort as in the cases of users in less favourable conditions.
- The Adoption Strategies proved highly satisfactory in coping with the training and support of users with varying degrees of computer literacy.
- One of the key points of success has been the resources consumed by GATE staff in moderating and animating the conferences. The critical importance of this point has been tested with the organization of another Forum on Mathematics teaching, which was run by a member of the faculty rising an extremely low degree of participation. In the case of the Forum on Educational Telematics, the design of the experience took 3 months of careful design, besides the effort devoted to running and monitoring. Again, a careful study of the human resources and costs implications of larger scale implementations has to be accomplished in order to make final decisions.

PE3. Pilot Experience 3 - GateCOM as a support to Academic Management

In October 1992, following several discussions about the possible uses of GateCOM, the Director of the Department of Languages at the UPM contacted us with the intention of organizing an experience through the service. This department is composed of 65 teachers divided into small groups (called Teaching Units) throughout the 19 UPM Schools. This factor of distance between the Teaching Units usually hinders the running of Departmental meetings. The Head of the Department believed that the virtual linking of the Teaching Units would bring a lot of improvements to the group.

PE3.1 Objectives

- To increase the effectiveness of the department meetings by extending the discussions in the time through the telematic system
- To enhance group communication possibilities of the group, e.g., by allowing a space for discussing minor administrative issues that cannot be raised in face-to-face meetings because of time constrictions
- To allow more participative decision-making procedures

PE3.2 Participants

This collective of teachers were the only faculty members with non-technical backgrounds. They all came from the field of Philology, and many had never used a computer. The most common computer skills were the use of word processors.

There are very good relations and cohesion among the members of this group. The majority showed their enthusiasm and motivation towards participating in the experience. This factors greatly improved the dynamics of the training sessions and reinforced the further on-line practice stage.

PE3.3 Information

News of the initiative was given in a letter from the Head of the department to the teachers, enclosing a questionnaire about the infrastructure available in each case. The idea was well received by the teachers, who appreciated the potential benefits of the system. We received a prompt response from 12 Schools.

PE3.4 Installation and Technical Support

The Language Units were minimal at the Schools, and most of them did not have network accesses. The PSTN connection seemed the most reasonable. It was then decided that the department would take charge of the purchasing of modems.

The strategy agreed in this case was to start with a subgroup of 36 people from the 12 interested Schools, for their current infrastructure allowed easier installation and connection of modems.

The implementation proved very easy. A member of the technical support group travelled to all the centres and installed the necessary hardware and software. In most of the Schools, informal induction sessions were actually held during these visits, since teachers showed enthusiasm about the technology and wanted some immediate hands-on practice.

PE3.5 Training

A 3-hour intensive training session was held in the month of December. The group was told about the functionalities of the system, and discussed several issues regarding connections and usability. Finally, in groups of 3, they entered the system and practised with it. The session ended only when every one of them had logged in and written a message.

In mid-February 1993, following the completion of the second installation process, a new training session was held with the 11 newcomers to GateCOM.

PE3.6 Design and moderation of conferences

A lot of discussions were held about who should play the role of the moderator for this conference. The Head of the Department considered in the first instance that, given the nature of the experience and the activities to be performed, she should take the 'electronic lead' personally. She was made aware of the extra effort that the activity might take, and it was finally agreed that a second person should support her with the writing and reviewing of messages, while she would dictate the guidelines of the conference discussions.

It was also agreed that a conference called 'Dept. of Languages - Practice' would be created, for teachers to tune-up and acquire familiarity until the whole group had been connected. While this was being achieved, the moderators would prepare discussion issues and organize conference dynamics. The Head of the Department suggested asking the Rector to write a welcoming message, encouraging the department to use this innovative medium.

PE3.7 Results

Participation in conferences

The period of practice started to get longer and longer, mainly due to the day-to-day excessive workload at the department which impeded the sending out of the kick-off messages.

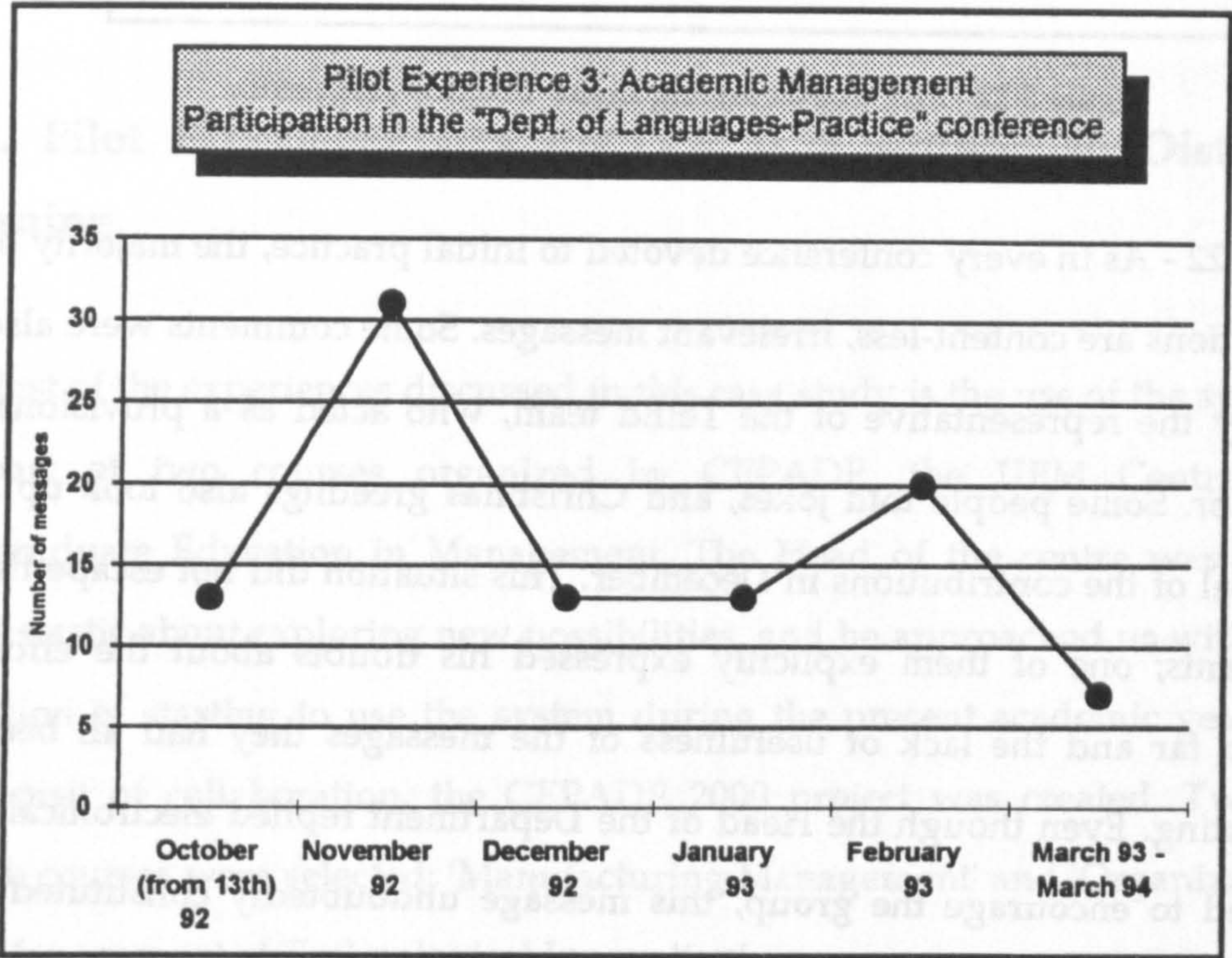


Figure 5.21 - PE3: Progression of the participation in the 'Practice' conference

Figure 5.21 - During the month of January, after the Christmas holidays, participation in the conference "Practice" started to decline. It experienced a new increase in February with new welcoming and test messages from the second group, but the topics covered were again superficial and far from the stated objectives.

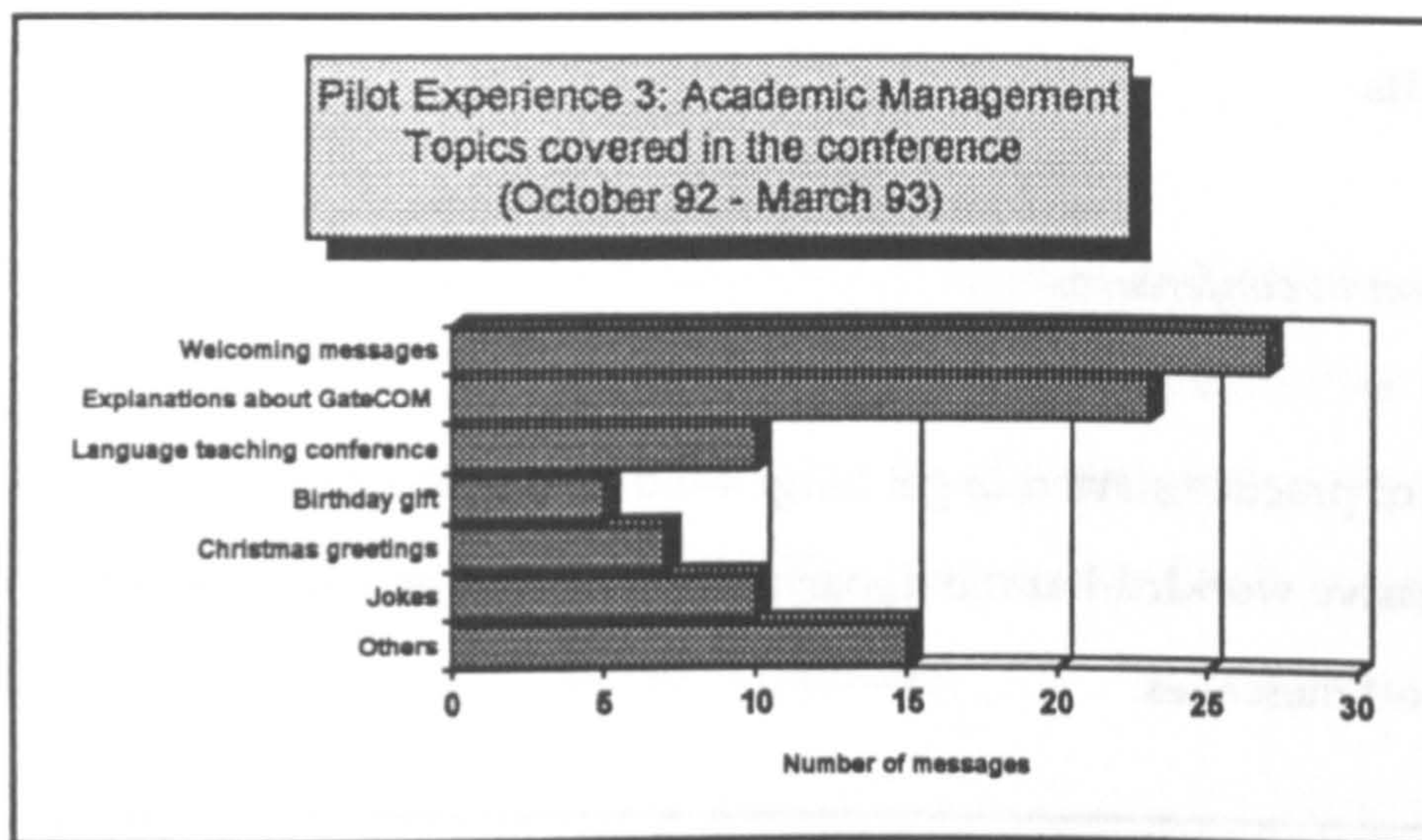


Figure 5.22 - PE3: Topics arising in the 'Practice' conference

Figure 5.22 - As in every conference devoted to initial practice, the majority of contributions are content-less, irrelevant messages. Some comments were also fed in by the representative of the TelEd team, who acted as a provisional moderator. Some people told jokes, and Christmas greetings also took up a good deal of the contributions in December. This situation did not escape the participants; one of them explicitly expressed his doubts about the effort made so far and the lack of usefulness of the messages they had all been contributing. Even though the Head of the Department replied electronically and tried to encourage the group, this message undoubtedly constituted a 'turning point', marking the start of the absenteeism. Only 7 messages have been sent in the March 92-March 93 period.

Given the lack of progress with the project so far, no quantitative data are available for the evaluation of perceived usability and usefulness.

PE3.8 Conclusions

- Despite the lack of quantitative evaluation data, the experience is highly illustrative in showing how users having proper infrastructure and

receiving extensive training and support can react after a period in which their expectations regarding the usefulness of the system are not met.

- This experience is also an illustration of the multiple shades of meaning that the term 'commitment' can have. In this case, the commitment should focus on giving meaning to the whole project through making contributions that would make participants feel the usefulness of the system, therefore stimulating participation.

PE4. Pilot Experience 4: GateCOM as a support to Distance Learning

The last of the experiences discussed in this case study is the use of the system as part of two courses organized by CEPADE, the UPM Centre for Postgraduate Education in Management. The Head of the centre was very enthusiastic about exploring new possibilities, and he approached us with the intention of starting to use the system during the present academic year. In this spirit of collaboration, the CEPADE 2000 project was created. Two 4-month courses were selected: 'Manufacturing Management' and 'Organization and Management of Technological Innovation'.

PE4.1 Objectives

- To test the suitability of the designed architecture at the UPM as a support to Distance Teaching activities on a national and commercial basis.
- To explore the possibilities of the medium in improving the tutoring processes currently run in CEPADE through telephone.
- To analyze the power of the system in increasing the effectiveness of the information flow between the administration and the students, as well as the delivery and correction of course assignments.

PE4.2 Information

The strategy followed was to send a letter to all the students enrolled in the two graduate programmes (around 300 people) where both courses were included. The letter stated the innovative features of the new medium, and the experimental nature of the new courses, and stated the availability of a PC as a necessary condition. It also encouraged students to participate and enhance their communication with the tutor and their peers, and offered a discount of 50% in the 200 pounds course fee to finance the purchase of the modem. Students could also decide to go back to traditional media in CEPADE (telephone and mail) so as to participate, if insoluble problems were met during the experience. A brief form was also enclosed to check the connection facilities of those interested people.

PE4.3 Participants

A total of 22 people sent back their forms and expressed an interest in the new course modality. The technical support group telephoned them all in order to provide more information about the project.

They were all familiarized with computers to some extent, especially at user application levels. Some of them already had a modem and had accessed other types of conferencing and e-mail systems. They expected that the system would be easy to use, and hoped to connect from twice a week to everyday.

Both tutors were teachers at the University School of Industrial Engineering. One of them had a high technical knowledge and was quite familiar with Telematics, while the other had scarcely used a word processor. Both were

enthusiastic about the new medium, and were willing to share both modalities of tutoring (traditional and GateCOM-based) and compare results with a view to planning more experiments within CEPADE on a wider scale.

PE4.4 Installation and Technical support

As students were sparse around the country, the installation process could not be directly made by the technical person at GATE. Consequently, instructions were sent for the physical connection of the modem and the loading of the communications software, and the telephone hotline was used by the TelEd team in a more active way than with other experiences. Phonecalls were made regularly to those users who had not succeeded in logging in, in order to closely monitor the process and diagnose technical problems.

PE4.5 Training

In very much the same way, the training process was performed completely on-line. However, this did not pose problems to users, who were accustomed to studying on their own and looked enthusiastic with the possibility of gaining integration in the courses.

PE4.6 Design of conferences

A conference was created for each of the course for private discussion. Other two conferences were open to all learners: CEPADE News, a read-only conference with administrative information, and CEPADE Aisle, for informal communication.

PE4.7 Results

Participation in conferences

Figure 5.23 and Table 5.8 - Except for two people, all the learners met the deadlines in submitting their assignments to their tutors electronically, via private mail. As for the discussion conferences, the participation has been much lower; users connected quite regularly to the system, but acted as lurkers in their majority.

There has only been a drop-out case, due to severe familiar problems.

	Classroom conferences	Aisle conference
Nb. of messages written by learners	21	52
Nb. of messages written by tutors	14	2

Table 5.8. PE4: Participation in the course conferences involving tutors and learners

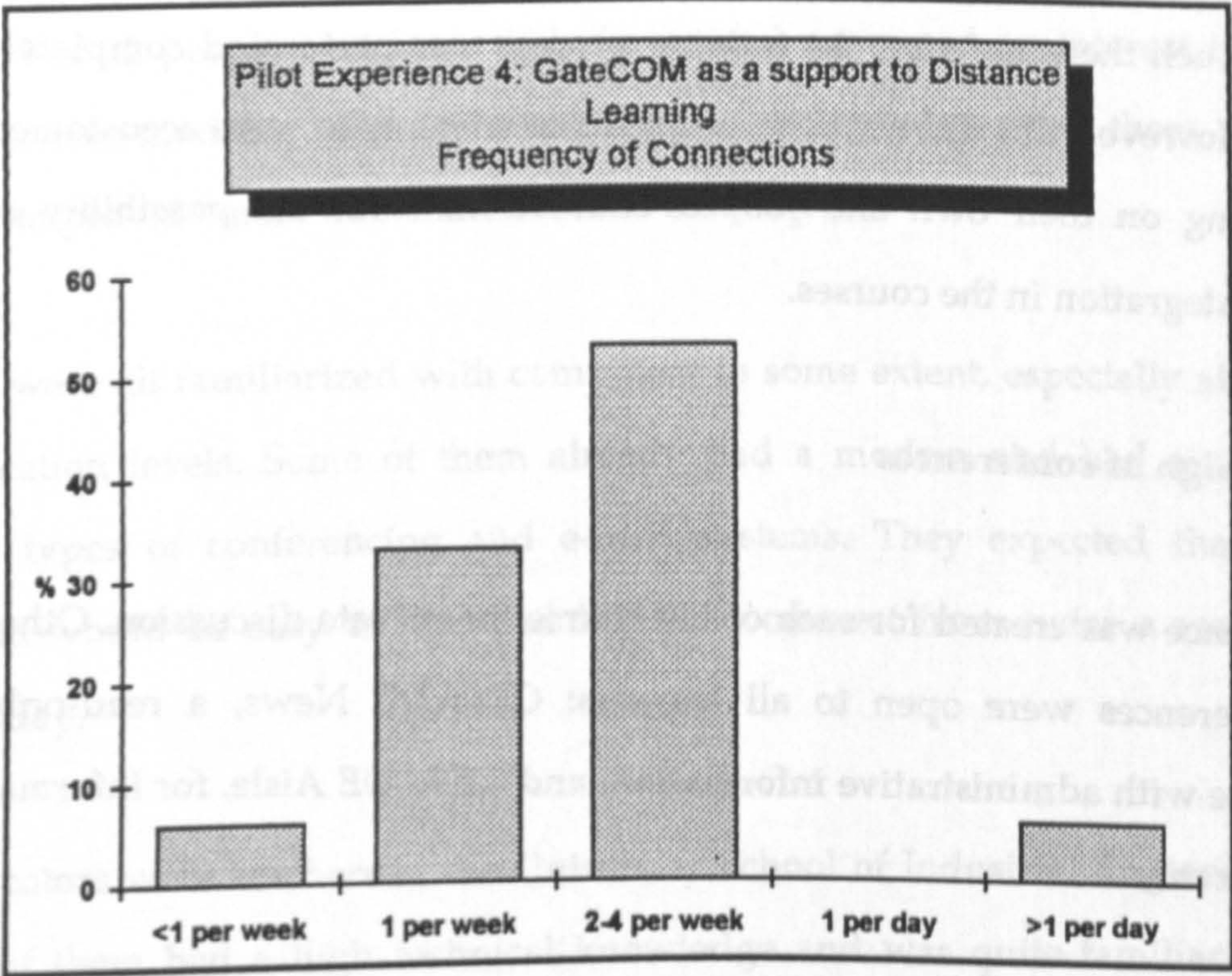


Figure 5.23. PE4: Frequency of connections to the system

Perceived usability

The system was found extremely easy to use by learners and tutors, though an important part of the group (58%) manifested that they would have devoted a longer time to practise with the system before starting course dynamics.

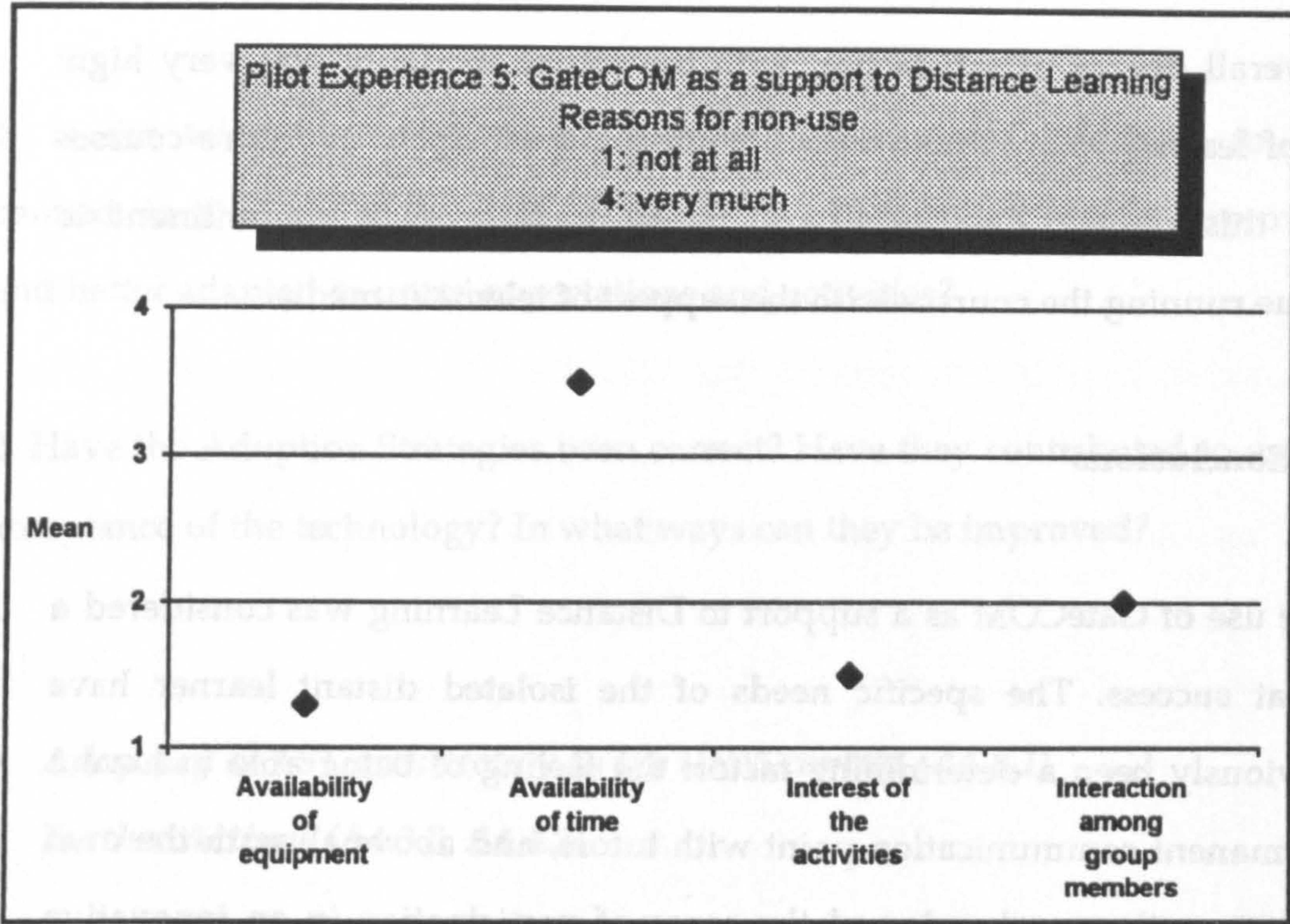


Figure 5.24. PE4: Estimated reasons for non-use

Perceived usefulness / Reasons for non-use

In this experience, GateCOM was used mainly for the exchange of course assignments, and in this sense it was considered highly useful and comfortable by every user. The conference discussions were not so successful, and, in the opinion of users, this was due to the lack of stimulating topics, case-studies to sort out in small groups, etc.

Figure 5.24 - The lack of time and work overload were the reasons alleged by users for not participating in the conferences as much as they would have

liked. As for tutors, they also made explicit that the use of the media involved a larger degree of effort and time to the course; they expressed their fear of investing too much time in moderating conferences, animating participation, tutoring individual students, designing group activities, etc. On the other hand, the whole number of learners (around 100) prevented the extended use of the media on the basis of effort allocation that their timetable permitted.

The overall degree of satisfaction with the course modality was very high: 100% of learners manifested their intention to participate in future courses within this project. On their part, tutors made explicit commitment to continue running the courses with the support of telematic media.

PE4.8 Conclusions

- The use of GateCOM as a support to Distance Learning was considered a great success. The specific needs of the isolated distant learner have obviously been a determining factor: the feeling of being able to have a permanent communication point with tutors, and above all with the own peers, on the one hand, and the sense of participation in an innovative experience, are the two reasons implicit in the learners' evaluation of the course that have decided CEPADE to try new experiences, even including more technological components (mainly ISDN videoconferencing for specific parts of the courses) in the CEPADE2000 project.
- The Adoption Strategies have proved to be highly satisfactory in this case as well, taking into account the low level of telematic literacy of the students and their final performance not only in participating in the conferences, but also in the sending out of the assignments to their tutors.

Step 4.4 - Plan Re-stating

The experimentation stage had constituted a valuable source of results from which the TelEd team had to propose a set of recommendations for further action in the programme. The issues addressed this time directly referred to two points:

1. Is the telecommunications architecture implemented adequate to the context, in the light of the data collected? In what ways it can be improved and better adapted to users' expectations and activities?
2. Have the Adoption Strategies been correct? Have they contributed to users' acceptance of the technology? In what ways can they be improved?

- *Adequacy of TST architecture to the UPM context (A4.4.1)*
- *Further Actions (A4.3.3, A4.4.2)*

It has already been commented several times that the experimentation stage was run on the basis of a very low budget. The positive aspect of this was the flexibility we had to make changes over the architecture and adapt to our conclusions.

The experiences can be overall considered a success. The tool in itself has been regarded as very interesting by the faculty. All the experiences, and also the meetings and demonstrations have been very welcome. Teachers have also punctually participated in the electronic courses and discussions organized by GATE. It is recognized the innovative character of the tool, and the revolution this can cause in the society in the next few years. But the

vision of the system operating as a support to their daily activities is not in the faculty's minds. Simply, they do not see how the technology 'can fit' in the practice: the face-to-face system is working fine for them. Therefore, if the question is: 'Was Computer Conferencing an adequate technology to support UPM academic activities on a wide scale?', the answer should be 'no'. The face-to-face communication is so firmly established, and the need for bridging the coincidence constriction is so strongly assumed by people that there seems to be no room for large-scale implementations of asynchronous technologies in this context.

The pedagogical exploitation of the telematic tool is another aspect that deserves consideration. Except for the Distance Education courses from CEPADE, there was not an only teacher willing to try the role of 'on-line tutor'. The Ph.D. course is a good illustration of this point, in showing the scarce relevance that the teacher concedes to GateCOM as a teaching tool. It was merely used as an organizational support to a non-changing face-to-face activity. Other approaches were not accepted neither by teachers nor by students. Obviously, the problem of lack of reinforcements is again central to this point.

In very much the same sense, the teachers participating in the training course run by GATE manifested their excitement in exploring the tool, and its interest. But the applicability of telematics was neither realistic from their point of view. They considered GateCOM as good for a Distance University, but again it did not fit in their teaching models. Some of them even communicated their fears about the teacher's role disappearing if such technologies would extend in educational contexts.

The TelEd team had to organize its experiences on a too individualistic basis. This has not been the case of GATE projects involving other

technologies; the video library project is a nice illustration to this point. The implementation of a video library cannot be supported on individual activities, but is rather a School-level operation involving all the UPM librarians. The setting up of the infrastructure, consequently, has been largely financed institutionally, and moreover has had a large repercussion at different levels. It has also been associated with the image of innovation that the UPM wanted to achieve.

The positive evidence of the non-adequacy of this type of architecture for a face-to-face context is the reaction from CEPADE. Not only students look enthusiastic about the media (some of them manifested that the communication through GateCOM was more interesting than course dynamics, which caused a strong reaction from one of the tutors!), but the tutors and the management now see the tool as having a future central role in the organization. A lot of problematic issues are arising from the experiences undoubtedly; but the relevance of the medium is out of discussion in this case.

Punctual uses of the system are still welcome by teachers, however. Again, the example of the Ph.D. course illustrates this point. On the other hand, even in spite of the bad results, the experience of academic management has shown how the faculty reacted quick and positively to the functionalities of the system to flexibilize their coordination mechanisms (of course, maintaining the departmental face-to-face meetings). Finally, participants in the Forum expressed the interest of running activities through the system on a mixed modality, that is, in combination with physical presence. But in all these cases, the acceptance of the technology heavily relies on the perception of usability on the part of the users. The effort to set up the infrastructure and get used to the system has to be compensated by 'finding something

interesting inside', on the one hand, and feeling supported for technical problems, on the other.

Which are our conclusions, then? Should there be major changes in the TelEd programme? Telecommunications have no room in a face-to-face context? Our main recommendations for further action in this sense have been:

- **The TelEd programme has been successful in experimentally creating a 'culture of Educational Telematics'. In the two years of operation of GateCOM, more than 200 members of the University have explored at different levels the tools, and have been aware of the functionalities of a Telecommunications service of these characteristics. This figure can be considered quite good if compared with the 6 respondents to the initial survey carried out by GATE. Conversely, more than 100 IDs have been opened to persons belonging to institutions outside the UPM. As for the diffusion activities, however, we think that the stage is now complete, in the light of the initial objectives stated for the programme.**
- **Pedagogical exploitation of asynchronous technologies has to be left in our case to the scenarios where there are real distance problems. The TelEd team has concentrated during this year all the efforts to the setting up of the experiences for CEPADE. We are still a service to the faculty as well (in fact, the second edition of the Ph.D. course is currently underway), but no resources are any longer allocated to the organization of sessions or experiences trying to 'capture' teachers to introduce GateCOM in their scenarios.**
- **Once the decision has been made that asynchronous Educational Telematics is not applicable to the UPM, we have explored other coming technologies that rather emulate face-to-face communication, as the**

architecture coming out of the approach suggested. The use of ISDN videoconferencing does not imply a substantial change in their conceptual teaching models, and would therefore support some of their activities and extend the face-to-face classroom to a wider audience. From this perspective, GATE has recently purchased a videoconferencing roll-about equipment and contracted an ISDN access to start the running of a new experimentation stage with this technology.

- There are other networking applications that may find a room in the UPM, eventually. The extension and popularity that Internet is gaining in social contexts, on the one hand, and the lots of services and applications developed in the few times over this network, on the other, has made us devote part of our resources to start exploring the Internet and think about the faculty's access to it. We have also discussed with CEPADE the possibility to start an Internet node as an electronic resource service to their students. The use of Telecommunications to open the University to the richness of information resources outside is likely the next project that the TelEd team will accomplish in the next stage of its activities.
- The context of recreating a face-to-face situation at a distance through videoconferencing technologies, if positively accepted, might extend the UPM activities to distant places in our country. In these cases, a real distance situation would emerge, and therefore for long actions (courses, seminars) the use of an asynchronous technology would be recommended and promoted as a complement.
- The implementation of a TST system of these characteristics requires for a proper adoption a level of institutional commitment in terms not only of central infrastructure, but at the users' level as well. In this sense, and given the fact that the UPM is now on the throes of offering the above

mentioned service over the Internet, it would be considered adequate to devote the TelEd team's efforts to support the implementation of such infrastructure, by developing and setting up the Adoption Strategies corresponding to this architecture, in the light of its experience and data regarding the potential users.

- *Evaluation of Adoption Strategies (A4.4.1)*
- *Further Actions (A4.4.2)*

We were happy to find positive results as far as the design and development of the Adoption Strategies was concerned. This was reflected in:

- users' evaluation of support materials in every experience, which in all the cases was very good,
- to some extent, their perceived usability of the system, especially in the cases of computer novices. None of the users alleged difficulties in the familiarization process. The on-line training also received positive comments, as well as the design of the face-to-face sessions, and finally,
- the assessment of the technical support received during the experiences, which again was perceived as very useful and positive.

What about the information and induction levels? Taken from the point of view of immediate satisfaction of the audience, the conclusion might be that the strategies have worked fine. We were able to maintain fruitful discussions with a lot of members of the faculty that greatly helped in the design of the experiences. However, if we evaluate it in terms of number of interested teachers suggesting an experience, the information level has risen very poor results. The initial stages of Adoption strategies, in which the objective is to 'hook' in some way the potential actors of the activities, possibly involves a set of psychological and social factors that deserve further research, in order to

make users overcome the barrier and set to work with the technology. But undoubtedly, having an immediate need that can be sorted out by means of the system is a key factor that did not actually exist in the context of our University.

In the light of these results, and regarding the new technology we are currently testing, the videoconferencing system, the strategies have a very similar approach. The information level is placing the emphasis in the ease of use of the system, the scarce requirements on their part, and on a cost-benefit comparative estimation (both in terms of time and money) of the use of the technology. The training and technical support levels are much easier to implement, conversely, therefore requiring less resources on our part.

Outputs of the System Implementation Stage

- Central system purchased and install - ready to run the service
- Users' infrastructure ready to be delivered and installed
- TST services set up
- Adoption Strategies materials ready to prepare users to work with the system
- Results of pilot experiences
- Evaluation of results and plans with further actions

Stage 4 - UPM TST Implementation

Key Actions and Results

Step 4.1 - Technical Installation

- Selection of Computing Centre to host the system
- Technical installation

- Users' infrastructure
Communications software
- Design of the service - logistic aspects and initial conferences

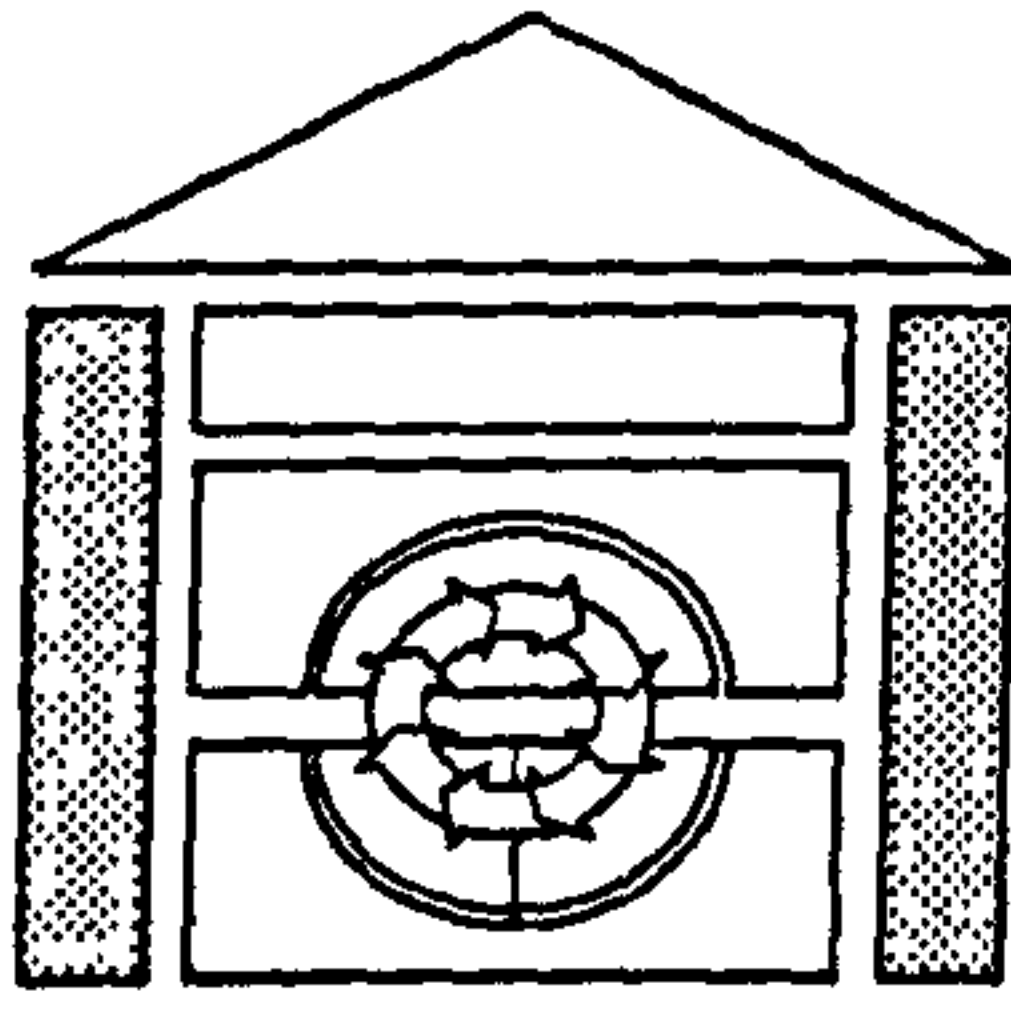
Step 4.2 - Setting up of Adoption Strategies

- Adoption Strategies materials development

Step 4.3 - Running of Pilot Experiences

Step 4.4 - Re-statement of Plan

- Conclusions and actions regarding suitability of technical architecture
- Conclusions and actions regarding suitability of adoption strategies



5.2.4. Stage 5 - TST System Maintenance

Step 5.1: Corrective Maintenance

hw / sw upgrades
System extensions
Technical problems
User support



Step 5.2: Prospective Maintenance

New functionalities
New developments
Emergent TS-learning models

Step 5.1- Establish Corrective Maintenance

- *Hardware and software upgrades (A5.1.1)*

While in operation, software upgrades for PortaCOM have been installed as they were delivered by the suppliers in Spain. The same is applicable to new versions of shareware, which was sent to users whenever it was considered to include major improvements, together with the corresponding documentation.

- *Extensions (A5.1.2)*

Mechanisms to cope with system's extensions were also implemented. For instance, as the number of users connecting through PSTN had increased very much, a NetBlazer router was purchased and installed in order to achieve better and faster access to GateCOM. Extensions of the PortaCOM database were also implemented as users and activities became more widespread.

- *Corrections to the system (A5.1.3)*

Connection problems or system's shutdowns were communicated to the Computing Centre for their rapid solution as they were detected.

- *Users support (A5.1.4)*

This was run by GATE, in coordination with the Computing Centre, as prescribed in the design stage.

Step 5.2- Establish Prospective Maintenance

- *New functionalities (A5.2.1)*

Off-line working facilities and readers and interfaces under Windows are some of the new functionalities currently being examined by the TelEd team as part of the prospective maintenance plan.

New telecommunication components are also explored, such as ISDN (increasingly extending in the area of Madrid, and therefore a strong candidate for migration of the services at the UPM) and the use of the Internet as a telematic resource accessible to the faculty.

- *Integrating emergent TS - Learning Models (A5.2.2)*

In the light of some of the conclusions from Stage 4, Step 4.4 (Implementation - Plan Re-stating), new models of Telecommunication support for the University are currently under study. New educational concepts for TST in Distance

Education are also explored for their testing under the CEPADE infrastructure for postgraduate education in the UPM.

5.3. Conclusions

- The ADAM approach has proved successful in designing a TST system at the Universidad Politécnica de Madrid. It has been able to:
 - explore the context and identify relevant factors affecting further design activities
 - come up with a model of the TST system for the UPM,
 - detect potential requirements and constraints for this architecture, as well as the opportunities it can offer,
 - provide different architecture alternatives, and select one of them by taking the above factors into consideration,
 - provide guidelines for putting the proposed design into practice,
 - carry out a set of previously designed pilot experiences aimed at testing the suitability of the architecture, and
 - draw up conclusions and recommendations for further practice.
- The Context Analysis and System Analysis stages have shown to be critical in providing the designer with the necessary information to make decisions about the most suitable architecture, both in terms of technical components and Adoption Strategies. However, a good deal of time and resources have been used during both stages, and therefore the willingness of a commercial organization to allocate a budget for these activities may be open to question. Similar problems have been reported in the field of Instructional Systems Development (ISD) (Hannum and Hansen, 1989). Consequently, the production of instruments aimed at

reducing the demands on time and resources during the analysis stages could well be required as a part of further developments in ADAM.

- The contrast between 'ideal' design situations and the reality of the implementation has been realized by the author when applying ADAM in this case study. This contrast has been most evident in the selection of pilot experiences designed to test out the architecture. the problem of finding teachers willing to make full use of the technologies in order to validate the suitability of the functionalities was so great that conclusions had to be drawn from a much more incomplete set of data than expected. The Human Activity nature of TST means that we should only cater for reasonable expectations when assessing predictability of the system.
- Research evidence from the pilot experiences shows that the actual use of the system, if compared with its potential functionalities, was very incomplete. The users have seen computer conferencing as a complement to face-to-face activities, and have used it in so far as it has not altered their daily activities. With this situation in mind, design, implementation and maintenance aspects do not compensate for its final utilization. As a consequence, new technologies and services are being defined that can be incorporated into UPM scenarios in a more profitable way.
- A phenomenon of 'polite rejection' has been detected in the users as a result of the evaluation of their participation in the system. The University atmosphere has perhaps made a good number of teachers approach the system, explore its usefulness and in some cases run a brief experience. In these isolated, individual acceptance has clearly been shown by users. However, there has been no intention to modify working habits on the part of the faculty. This problem poses interesting questions regarding the relations between the concepts of Acceptance, Adoption and the dynamics

they both can generate in our global TST model. Acceptance seems to be a very psychological concept from our point of view, while Adoption rather has an organizational meaning.

- Interestingly, the lack of an immediate need to use telematics has increased both the usability and the usefulness thresholds. The motivation that the users might receive from the organization, which provides the reasons for using the system, was non-existent in this case. System use consequently depended to a large extent on individual willingness both from the TelEd members and the users themselves. This situation is a good illustration of what the consequences of a 'lack of commitment' in the organization may be, even if the institution is providing financial resources for the project.
- An important conclusion, which has also been remarked in relation to the use of ADAM as an analysis tool, is the power of the systematic approach specifically in detecting and predicting adoption factors and problems. The initial stages of analysis have in fact shown the potential limitations for a successful implementation of a TST at the UPM, in terms of aspects such as the attitudes of strategic management, the situation of many particular Engineering Schools and the faculty in general. The approach also recommended activities and techniques for detecting driving forces and possible "change agents" (running of interviews and application of survey), whose negative results prepared the TelEd team for coping with most of the problems that became real during the process. This capacity of ADAM can undoubtedly be regarded as one of its strongest points, mainly because it prevents the organization from making large investments (usually required in any technological venture) which are further rejected both by the organization as a whole and by the particular users. In this sense, the emphasis the approach places on the carrying out of a

experimental stage providing objective and observable results, greatly contributes to the confirmation of these indicators of the potential degree of adoption, and therefore strengthens the approach.

- As in the previous case study, a final comment concerns the author's personal experience of ADAM application in a real context. The professional profiles of the TelEd members are of the kind described by Earl as 'hybrid', that is, training specialists with a technological background. This meant that we were very familiar with the terminology and methodologies used by the technology experts. Therefore, the highly positive experience of applying the approach cannot be extended to other types of managers or researchers with a non-hybrid background. In this sense, the development of instruments (checklists, questionnaires, etc.) would be of great help to less experienced users of ADAM in following its guidelines.

Chapter 6

Conclusions

6.1. A Global Model of TST Systems

6.2. A Systematic Approach to the Design of TST: Evaluation of ADAM

6.3. The Power of ADAM as an Analysis Tool

6.4. Contributions made by this Work

6.5. Further Study

This thesis has focused on the development and testing out of a systematic approach to the analysis, design and implementation of Telecommunications-Supported Training Systems. As was stated in the first chapter, the value of this type of approach lies in its contribution to expanding knowledge in this field, both from the practical point of view, in proposing a problem-solving procedure, and from a theoretical one, in helping to understand the problem addressed by the approach.

The conclusions from this work may have implications for one or both angles, since they are deeply interconnected with the answers to the Research Questions set out in Chapter One. In this sense, a very significant aspect that should be pointed out here is the highly interactive and dynamic nature of the relations between the development of the systematic approach, its application in the real world and the evolution of the global model as a result of these two processes. Actually, the model serves as a basis for the design of the approach; but, at the same time, during the design process, the model itself is open to revision. Equally, when the approach is put into practice, real world data reveal factors that help to refine and expand the original model. It is precisely along these lines

that the method of work, as several authors show (Hall, 1989; Branson and Grow, 1987) proved useful.

Discussion of results have been drawn up in the case studies. As for this chapter, the conclusions will be presented according to the answers they provide to the Research Questions stated in Chapter One. The list of problems and possible solutions also included in this chapter will act as a reference in outlining the contributions that this thesis has made to the fields of TST research and practice. Finally, I have made suggestions for further avenues of research in the light of the conclusions reached by this study.

6.1. A Global Model of TST Systems

The first Research Question was: How can a TST system be defined from the perspective of a systematic approach? Based on the long-established principles of Systems Engineering, and with the concept of TST Architecture as a conceptual core, a TST model has been created (see Figure 3.1). The Human Activity nature of TST systems is implicit in the architectural conception, their purpose being to effectively support the tasks that users have to carry out by virtue of their assigned role in the organization. This Human Activity nature has largely determined the importance of individual and contextual factors in the model, which has been defined as user-driven: it is the people themselves who have to decide on the suitability of the technology which is to assist them in carrying out their tasks. The conception of this type of system as 'purposeful', according to the definitions of Checkland (1990) has also influenced the model by combining technical components and social aspects into a whole in which the users, in view of their different backgrounds and outlooks, react to the use of the technology and make a set of decisions concerning its incorporation into their daily activities.

It is precisely in the area of user reaction that the model has evolved as a result of experimental data. Research literature has shown that the issue of user satisfaction and the acceptance of innovations is related to perceptions concerning the usability and usefulness of the tools. In our case, the concept of acceptance has been equally characterized in the context of TST, directly depending on both the usability of the system and its usefulness. The balance between these factors and their relation to the degree of acceptance is expressed in the following way:

$$\frac{\text{Usefulness}}{\text{Usability}} > 1 \Rightarrow \text{Acceptance}$$

where Usefulness can be defined as the extent to which the user perceives that using the telecommunications service will support the activities defined by his/her role in the system, and Usability is understood as the user's estimation of the time and effort he/she has to devote in order to become familiar with the service.

It is derived from the premise that for Acceptance to exist, the result of the quotient has to be greater than one. This implies that people have to perceive that the benefits of using the service compensate for the costs incurred by becoming regular users of the system.

This conclusion is in line with works such as that published by Davis (1993), within the scope of Information Systems, and supports the definition of acceptance put forward by Kerr and Hiltz (1982), which has formed the basis of the evaluation framework used in this study. However, a number of conclusions drawn from the experimental data do not fully coincide with the findings of these researchers.

- In perceiving the usefulness of a service, the user is carefully taking into account the benefits that can be obtained. Such benefits may belong to different categories: personal, social, economic, etc. In the UPM case study, the faculty perceived the benefits that the organization might enjoy by using the system; however, their lack of perceived personal benefits led in some cases to a non-acceptance decision (or a 'polite rejection', as described in Chapter Five). In the design of TST systems, therefore, a careful analysis must be made of the benefits corresponding to all the dimensions considered by the user, and awareness of such benefits should be further increased in the minds of users by means of different strategies, if the level of acceptance of the service is to rise.
- As the work by Kerr and Hiltz states, the concept of Acceptance is studied in a much better way in environments where users are free to choose between using the system or keeping to their current habits. The UPM case reflects this situation; being a University, the faculty has a high degree of autonomy in work activities. This has resulted in an insufficient use of the system, relative to the resources devoted to its design and maintenance. Under these conditions, the cost-effectiveness of the system, and consequently its success, could be open to question.
- The concept of Adoption also warrants reassessment in the light of the case study findings. The original definition of Adoption by Rogers (1982) as "...a decision to make full use of an innovation as the best course of action available" applies to "...an individual or a decision-making unit" (p.21). Data from the MTS case, however, show that the Adoption process is a much more complex one, in which this decision is a necessary but insufficient condition. The view expressed in this thesis is that Adoption is a macro process involving individual acceptance on the part of users as well as the organizational restructuring defined by Conley (1993), that is, changes in assumptions,

practices and interrelations both within the organization and outside it. The case of DB Telekom is a good illustration of an organization taking its first steps towards Adoption: new roles are being defined and new conceptions of distance education processes are being developed as a result of the successful implementation of a TST service. Conversely, the UPM, even when the users have shown a high level of Acceptance, has not shown any indicator of organizational change as a result of the implementation of the telematic system. This has brought about a restatement of the plan which discusses other types of services better suited to institutional requirements.

- A source of factors critical to adoption stems from what has been broadly named **organizational commitment**. This is a multi-dimensional concept, not easy to analyze. The decision to make a financial investment has been cited repeatedly in the literature as a relevant indicator of commitment; the implementation of MTS in DB Telekom points to other factors, such as the allocation of human resources, and the setting up of fluid information channels among the groups more or less directly involved in the project. For its part, the UPM has discussed another shade of the meaning of commitment, as it affects the degree of usefulness of the system in the perception of the users. The use of the computer conferencing service for academic management was the only experience in which the management provided infrastructure for every user; however, it failed to show the promised improvements in working dynamics, which led to the general withdrawal of the system.
- The design of a set of strategies aimed at creating conditions favouring the introduction of the system into the organization, actually called **Adoption Strategies** in the ADAM approach has been revealed as a key factor in the successful implementation of TST systems. This leaves the designer with a good deal of responsibility for the ultimate effectiveness of the system. The initial analysis of the organization has proved to be a key aspect in the design

of such strategies, by offering a complete review of the requirements to be met by the system, and the opportunities and benefits it can bring to the organization. The precise identification of the activities that the system will support is also relevant to the design of the Adoption Strategies.

- Results from the case studies have also illustrated how the Adoption process happens. DB Telekom reported that the positive reactions of users towards the MTS courses set off an initial set of changes at the organizational level. The case of the UPM Distance Education Centre, CEPADE, also offers a good example of the following relation: 'acceptance / improved performance / revision of organizational characteristics'. The enthusiasm shown by the students, and the high level of acceptance on the part of the tutors, made the management extend the scope of application, create the role of 'multimedia coordinator' and modify in some way the conception of the delivery of Distance Learning as it had been understood for the previous few years. Consequently, some kind of 'feedback loop' should be included in the model, from the concept of acceptance to the organizational features that represent the degree of Adoption of the technology and how it filters down through the rest of the components.
- A final conclusion about the model concerns its User-centred nature. The conclusions from both case studies reinforce the need to reduce the technology-driven character of these systems, but also point to the desirability of a balance between the user and the organization. One of the most important lessons from the UPM experience is that a too strong emphasis on the user leads to individual acceptance, but by no means guarantees adoption. Therefore, contextual factors have acquired importance in the model, whenever it has been compared with real TST systems.

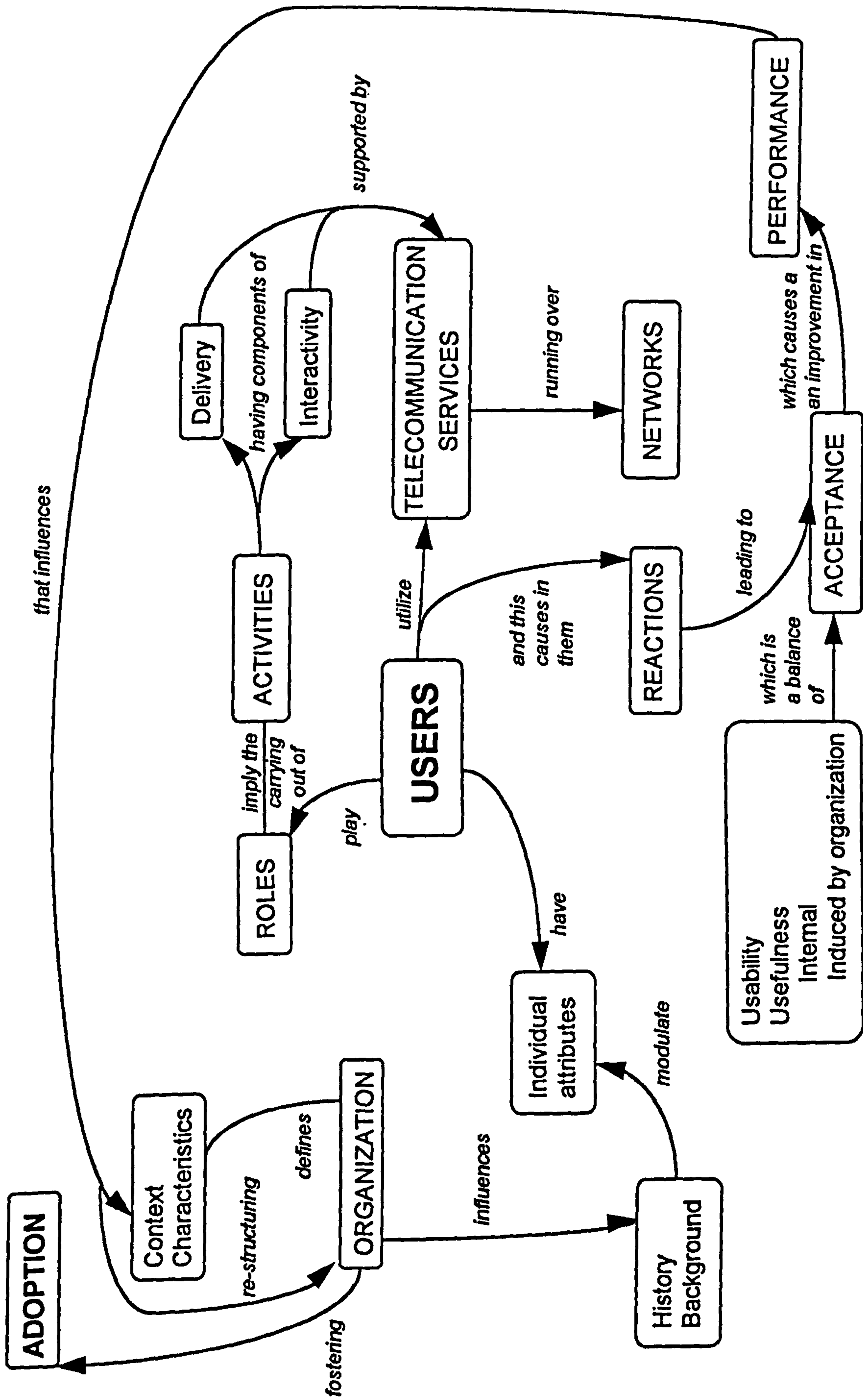


Figure 6.1. User-Centred TST Model extended as a Result of the Application of the ADAM Approach

The conclusions stated so far have indicated the need for a modification of the original model, giving rise to the improved one shown in Figure 6.1. As we can appreciate, the definition of the concept Acceptance has been analyzed in detail. The map of components and relations illustrates the topic that has just been discussed.

6.2. A Systematic Approach to the Design of TST: Evaluation of ADAM

The second Research Question explored how a systematic approach should be capable of dealing with the design of TST systems in the real world. In an attempt to provide a practical answer to this question, the ADAM (Architectural Design and Adoption Model) approach has been developed. The background to its conception was provided by well-established Systems Analysis and Engineering Methodologies. The global TST model has also served as a theoretical basis for the creation of ADAM. It has been designed as a five-stage model including context analysis, system analysis, design, implementation and maintenance. Every stage has been defined in terms of its steps and activities, with reference to a set of outcomes and deliverables to be produced as a result of these activities.

The elaboration of the 'system value' of the ADAM approach gave rise to the definition of a series of requirements, as well as the additional evaluation criteria described in Chapter 3, section 3.4. An estimation of the validity of the approach will now be made in the light of these criteria.

- *The approach should be capable of detecting relevant contextual factors affecting the design.*

The activities performed at the Context Analysis stage focus on the investigation and identification of organizational factors which have turned out to be very relevant in the design decision-making process. Specifically, the training culture at the UPM has such a strong influence on the design that, as one of the conclusions from the case study states, only those technologies emulating this modality have any chance of short term success. Equally, the MTS case has shown the importance of identifying key members of the groups potentially involved in the implementation of the TST system. The 'technology culture', or previous experience with telecommunications and computers, has implications that make a study of these aspect an essential part of this stage of the analysis.

Likewise, one of the conclusions from the MTS case study is that the ADAM approach is a good explorer of non-technological aspects. It was able to foresee some of the hazards that put the project at risk during the implementation, and which in the case of the Spanish organization caused a partial withdrawal from the project.

Finally, the analysis of Requirements, Constraints and Opportunities (A. 2.2.1-2.2.3) represents a further elaboration of the contextual factors into a set of recommendations for the design decisions. The attention paid to RCO has greatly avoided the technological character of the final decisions that are so common in TST projects.

- *The approach should be capable of identifying the impact that the new system will have on the users, and should incorporate necessary procedures for overcoming implementation barriers.*

This requirement, which is quite often found in many types of value systems, acquires particular importance in the case of TST, due to its innovative nature. The approach has proved to be capable of anticipating the reactions of people, and of using this information as the basis for the design of the Adoption Strategies. The satisfaction of users with the actions designed and implemented in the case of the UPM has meant a high level of individual and group acceptance, as discussed in the previous section. For its part, the MTS case has also been characterized by the positive estimation of the induction actions, the training and especially the technical support that users reported during the evaluation. However, we must remember the high cost in terms of human resources that the design and implementation of the Adoption Strategies can entail, a feature which has important implications in an overall study of the cost-effectiveness of TST systems, especially if the final use of the technology is limited, as was the case in both situations.

- *In taking the TST model as a theoretical basis, the approach should be user-oriented*

From its earliest stages, the ADAM approach has a remarkable user orientation. This is shown by the involvement of every type of potential user during the Context Analysis Stage, illustrated in the UPM by the use of different techniques (interviews, questionnaires) to collect as much information as possible about user expectations of the system. Equally, during the System Analysis stage, users were again involved and expressed their views on the ways in which the system should effectively support their daily work, this information constituting the basis of the modelling process. The carrying out of pilot experiences also aimed at obtaining a feeling of satisfaction on the part of the users, measured by the degree of acceptance that they report through the variables defined by ADAM's evaluation

framework (usability / usefulness / actual uses of the system / reasons for non-use / improvement factors).

In relation to this point, it was stated in the previous section that one of the modifications of the user-centred model resulted in more importance being given to the organizational factors. Future experimentation with the use of ADAM in different organizations will show if this balance must also be applied to the approach, and, if this is so, what type of change should be made to ADAM.

- *The approach should provide a structured procedure for teamwork, facilitating the creation and operation of multidisciplinary teams.*

At every stage, ADAM includes a reference to the professional profiles that should be involved in analyzing, designing and implementing the system. Besides, it provides recommendations of deliverables that should be produced or which should emerge as a result of the work carried out during any of the stages. This guarantees a clear allocation of responsibilities and leads to project result accountability.

As for the participation of different professionals in the design decision-making process, data from the UPM case are by no means conclusive, since the people from the TelEd team have a mixed profile along the lines of the 'hybrid manager' proposed by Earl (1989) for IS systems development. Though the inclusion of this profile can be viewed as the best alternative in designing TST systems, this is not the case in many organizations. Regarding the choice of the interdisciplinary team, experiences do demonstrate the importance of experts in human factors and training. The case of MTS, in which the technological components become less important than organizational factors, conforms to recent trends in Information Systems

(Galliers, 1993), in which the role of IS manager switches from developing technical systems to giving advice on their integration into the organization. Research evidence from this work shows that the hypothetical role of 'TST manager' would have similar responsibilities.

- *From a research point of view, the approach should be capable of increasing comprehension of how a TST operates, thus expanding the knowledge base in this field*

The ADAM approach has mainly contributed to increasing knowledge of the structure and functioning of TST systems by having been able to modify the theoretical model as a result of its application in the real world. The changes to this model have already been discussed as they have been instrumental in providing answers to the first of the Research Questions.

Additionally, the distinctive character of the approach represents the sort of input that also helps in learning about the process of designing and implementing the system from a practical viewpoint. For instance, it introduces logic in steps and stages in a way that is neither trivial nor apparent to the practitioner, and which has important implications for projects involving the investment of large amounts of resources. Equally, in categorizing factors for the analysis and design, it provides 'organized thinking' about the process, and opens up the possibility of incorporating new factors and concepts as a result of its use in varying contexts and conditions.

- *The approach should be useful both in designing new TST systems as well as in analyzing the ones already existing in the real world.*

ADAM has shown its capacity to design a system for the Universidad Politécnica de Madrid, by:

- identifying not only contextual factors, but also driving forces and potential barriers to the introduction of the system
- modelling the TST system on the principles of architectural design,
- proposing different design architecture alternatives,
- selecting the architectural solution in the light of the requirements, constraints and opportunities detected
- testing the suitability of this architecture through the design of a set of pilot experiences, and
- being able to restate the system as convenient and recommending further actions

Research data have proved that the above evaluation criteria have been met during this process. Therefore, it can be affirmed that ADAM has been useful in designing TST systems.

It should be stated, however, that the specific conditions of the context in which ADAM has been tested, namely, a University aiming merely at exploring the possibility of using telecommunications with a view to the long term, may mean that the results found cannot lead to generalizations about other organizations, which can be markedly different regarding the use of resources, the objectives pursued, and the profile of the users.

6.3. The Power of ADAM as an Analysis Tool

The last of the evaluation criteria, that is, the capacity of the ADAM approach to analyze TST systems that already exist in organizations, forms the core of the last Research Question. Based on the results obtained for the MTS case study, the answer is clearly positive:

- The application of the ADAM approach has led to the production of a TST model which is substantially different from the one guiding the implementation of MTS. Interestingly, the main source of disagreement about the models concerns the contextual and human factors, both being technical architectures, very similar in their selection of services and networks.
- Experimental data from the evaluation of two different user organizations involved in the project has supported the main points to emerge in the analysis, concerning the non-technical components of the architecture. In this sense, as I concluded in Chapter Four, ADAM has proved to be a good 'detector' of the human and organizational factors critical to a successful implementation.
- The question of how ADAM has been used for this specific purpose is not easy to answer, however. In the first instance, the MTS system is of a very different nature to the hypothetical one addressed by the approach, in being commercially available to a wide range of organizations. This difference has been reflected in the definition of two different subsystems during the modelling process, with the subsequent implications for comprehension of the TST systems field. The range of TST systems may actually be varied, and the value of ADAM in this sense is its capability for modelling them so as to identify their particular features and make recommendations for the design. Other aspects of the approach can also be used, but rather as checklists of factors to be taken into account than as a step-by-step procedure.
- The previous consideration is also along the lines of current trends in IS systems, which, as I suggested at the beginning of the thesis, act as forerunners for the field of TST. The compilation by Avgerou and Cornford (1993) illustrates the fact that methodologies should become flexible tools rather than rigid sets of prescriptions. In this sense, ADAM has shown itself to be versatile

enough to deal with the analysis of systems which greatly differ from the one hypothetically underlying its own development.

6.4. Contributions Made by this Work

Chapter One identified some of the problems currently existing in the field of TST, and outlined possible solutions to them. They will now be summarized in order to identify the ways in which this thesis has contributed to the field of TST systems research and practice.

6.4.1. Contributions to Research into TST Systems

- The User-Centred TST Model provides a terminology for the definition of this kind of system. It also offers a comprehensive view of the structure and functioning, states the attributes of the main components, and defines the broad relations among them. In this sense, it provides a framework in which incremental results and conclusions from research can be shared and interpreted in an integrated way.
- If properly followed, the ADAM approach guarantees a balance between technical, individual and organizational factors. This benefit avoids partial study perspectives, and helps people with different roles to work collaboratively and unite their efforts in the accomplishment of a common goal.
- The approach has also outlined a comprehensive evaluation framework for the design of TST systems, based on the concepts of Acceptance and Adoption. Though a lot of research is still to be carried out in this area, this represents an initial step in the consideration of all the factors involved in

these highly complex systems, under the holistic umbrella provided by the concept of architecture.

6.4.2. Contributions to the TST Systems Design Practice

- The ADAM approach has contributed a systematic procedure as regards the analysis, design and implementation activities. It also specifies who should participate, and what the outcomes and deliverables of every stage should be. In this sense, it provides the TST project manager with a useful tool for monitoring and controlling the process.

However, it is important to note here that the testing out of the ADAM approach has so far only been performed by the author. In this sense, in order to state conclusively that the approach is a good tool for managers in general (within the scope of users defined in Chapter Three, Section 3.5.3, 'Profile of the ADAM Practitioner'), more experimental work is required.

- The approach does provide a good tool for putting different professionals in communication, through the provision of a terminology, not only regarding the conceptual model, but also the stages, steps and activities to be undertaken. It is common to find different meanings for the terms 'design' or 'implementation' which are described clearly and uniquely under ADAM.
- As for the research application, the approach, in being holistic and placing emphasis on human and social factors, heads off the technology-driven tendency that has been found to be so usual in these projects. If used by a training manager, ADAM provides the keys for translating activities into functionalities that form the basis for communicating with technical experts. Conversely, if used by a technology professional, it increases awareness of the

human and contextual factors that are elaborated into design requirements which modify technical decisions.

6.4.3. Unique Contributions

The present thesis has contributed to the literature in this field in a unique way by:

- taking the lead in proposing an integrated, systemic model of TST, combining technical, human and organizational aspects**
- developing a conceptual basis for the analysis of these systems around the concept of architecture, balancing the considerations of technologies, people and context**
- in so far as the author has been able to explore research literature in this field, it is the first systematic approach to be developed, based on well-established methodologies (Systems Engineering and Soft Systems Methodology), and taking into consideration the lessons learned from parallel applications of technology-supported systems in organizations, such as Information Systems Development, Instructional Systems Development and Innovation Theory Applications. In this sense, it can complement other frameworks already developed which place the emphasis on more technical aspects (CTA, Verreck et al., 1993).**

6.5. Further Study

The comprehensive nature of this work means that it covers many different areas of research. On the other hand, despite the growing number of applications to have emerged in the last few years, the field of TST systems is still at an early stage, with many avenues of research having been initiated, but a lot of further

study is required in practically every one of them. Consequently, as exploratory work, the thesis raises a number of questions that deserve further investigation.

As far as the theoretical basis is concerned, that is, the refinement of the model, attributes of the components have to be researched further. The relations among the components also pose questions of relevance, e.g., in relation to the characterization of the Adoption Process. The influence of psychological variables and the concept of Acceptance are also aspects which demand further attention.

As for the ADAM approach, a lot of research work is still to be done. The testing out has been performed in very specific environments, and a set of experimental uses is required before reaching definite conclusions about many of its aspects.

Several enhancements would also be of interest in relation to the approach. First of all, as it has been repeatedly discussed throughout the thesis, the use of such type of approaches is regarded as a creative process. However, given the highly interdisciplinary nature of the work, the development of a set of guidelines, checklists and instruments would no doubt be very useful for novice practitioners and training or technology experts who may not be acquainted with the other disciplines covered by ADAM. On the other hand, although the Context Analysis stage has proved effective in detecting driving forces and negative factors which foresee the results of the implementation of a TST in a given organization, a more explicit Feasibility Study might be included in these initial activities, providing more objective data for discussing with the management before proceeding further in the process. Specific tasks of project management, such as timing or teamwork procedures would also be worthwhile to study in order to produce guidelines, estimations and tools.

Finally, most of the factors pointed out at the Analysis stage require additional research to enrich the approach. These include, for example, cost-benefit analysis,

organizational structures and processes regarding the use of technologies in different types of training environments.

References

- Alexander, G. (1992). Designing Human Interfaces for Collaborative Learning. In Kaye, A.R. (Ed.) (1992). *Collaborative Learning Through Computer Conferencing. The Najaden Papers*. NATO ASI Series, Vol. 90. Springer-Verlag, Berlin.
- Alexander, G. and Mason, R. (1994). *Innovating at the OU: Resource-Based Collaborative Learning Online*. Internal Report, no. 195, Centre for Information Technology in Education, Institute of Educational Technology, The Open University.
- Andreu, R., Ricart, J. and Valor, J. (1991). *Estrategia y sistemas de información*. McGraw-Hill, Madrid.
- Anthony, R.N. (1993). *El Control de Gestión (The Management Control Function)*. Ed. Deusto, Bilbao.
- Artman, J.M. and Roden, P. (1992). Project Athena: Supporting Distributed Computing at MIT. *IBM Systems Journal*, 31(3), pp. 550-563.
- Asselborn, J.C. and Jans, J.M. (1989). Learning Environment in the Professional World. *DELTA Multimedia Journal*, 1, Oct. 1989, pp.67-72.
- Avgerou, C. and Cornford, T. (1993). A Review of the Methodologies Movement. *Journal of Information Technology*, 8(4), pp 277-286.
- Baddeley, J. (1991). Case Study: Implementing New Systems at Penguin Books. *Journal of Information Technology*, 6, pp 108-111.
- Bates, A.W. (1991). Third Generation Distance Education: The Challenge of New Technology. *Research in Distance Education*, April 1991, pp.10-15.
- BEACON Consortium (1994). *Final Implementation Handbook*. Public Deliverable, No. 2, Transcend Technology Limited, Rugby, UK.
- Beard, J.W. and Peterson, T.O. (1988). A Taxonomy for the Study of Human Factors in Management Information Systems (MIS). Carey, J.M. (Ed.). *Human Factors in Management Information Systems*. ABLEX Pub. Corp., New Jersey.

- Block, S.H. (1992). Applying Technology to Workforce Training. *Interactive Learning International*, 8, pp. 311-314.
- Boehm, B.W. (1987). A Spiral Model of Software Development and Enhancement. *Software Engineering Notes*, 11(4), pp. 128-142.
- Boettcher, J. (Ed.) (1993). *101 Success Stories of Information Technology in Higher Education: The Joe Wyatt Challenge*. McGraw Hill, New York.
- Brande, L. van den (1993). *Flexible and Distance Learning*. John Wiley and Sons, New York.
- Branson, R.K. and Grow, G. (1987). Instructional Systems Development. In Gagné, R.M. (Ed.). *Instructional Technology: Foundations*. Lawrence Erlbaum Associates, New Jersey.
- Briefs, U.; Ciborra, C. and Schneider, I. (Eds.) (1983). *Systems Design For, With and By the Users*. IFIP Proceedings, New Holland, Amsterdam.
- Buckley, R. and Caple, J. (1990). *The Theory and Practice of Training*. Kogan Page, London.
- Carey, J.M. (Ed.) (1988). *Human Factors in Management Information Systems*. New Jersey, ABLEX Pub. Corp.
- Carter, R.; Martin, J.; Mayblin, B. and Munday, M. (1984). *Systems, Management and Change*. Paul Chapman Publishing, London.
- Cassidy, S. and Lane, C. (1994). Planned Change and Adoption of Distance Learning. *ED Journal*, 8#8, pp.11-19.
- Cawkell, A.E. (Ed.) (1991). *World Information Technology Manual*. Elsevier, Amsterdam.
- Checkland, P. (1981). *Systems Thinking, Systems Practice*. John Wiley and Sons, New York.
- Checkland, P. (1985). Formulating Problems for System Analysis. In Miser, H.J. and Quade, E.S. (Eds.) *Handbook of Systems Analysis: Overview of Uses, Procedures, Applications and Practice*. John Wiley, New York.

- Checkland, P. and Scholes, J. (1990). *Soft Systems Methodology in Action*. John Wiley, New York.
- Collis, B.; Veen, W. and DeVries, P. (1993). Preparing for an Interconnected Future: Policy Options for Telecommunications in Education. *Educational Technology*, XXXIII(1), pp. 17-24.
- Coopers and Lybrand Associates (1989). *A Report into the Relative Costs of Open Learning*. Manpower Services Commission and National Development Office.
- CTA Consortium (1993). *CTA: Description and Definition*. CTA project, public deliverable No. 6, OTIC, Open University of the Netherlands.
- CTA Consortium (1994). *CTA Overview*. OTIC, OU of the Netherlands.
- Damodaran, L. (1991). Towards a Human Factors Strategy for Information Technology Systems. In Shackel, B. and Richardson, S. (Eds.). *Human Factors for Informatics Usability*. Cambridge University Press.
- Davis, F.D. (1993). User Acceptance of Information Technology: System Characteristics, User Perceptions and Behavioral Impacts. *Int. J. Man-Machine Studies*, 38, pp. 475-487.
- Davies, G. and Samways, B. (Eds.) (1993). *Proceedings of the IFIP TC3: Third Teleteaching Conference, Teleteaching 93*. North-Holland, Amsterdam.
- DELTA Programme (1994). *Proceedings of the DeCoMe 13, "Implementation - Future Perfect"*, 5-6 May. Commission of the European Communities.
- DELTA Programme (1991). *Exploratory Action. Final Technical Report*. Commission of the European Communities, May 1991.
- Dempsey, L. (1993). Research Networks and Academic Information Systems: Towards an Academic Information Infrastructure: Part 1. *Journal of Information Networking*, 1(1), pp. 1-27.
- Dick, W. and Carey, L. (1990). *The Systematic Design of Instruction* (3rd. Edition). Harper Collins Publishers.
- Dorrell, J. (1994). Setting Up a Flexible Learning Centre for the Defence Research Agency: A Case Study. *Open Learning Today*, September, pp. 10-12.

- Dremeau, I. and Elz, W. (1994). Multimedia Teleschool at Deutsche Bundespost Telekom. In Sippel, F. (Ed.). *Implementation and Management of Teletraining*. Proceedings of the Wissenschaftliches Institut für Kommunikationsdienste Workshop. Brussels, November 30, 1993, pp. 31-35.
- Ehrman, S.C. (1994) US Higher Education in 1998: How it Might Use Technologies for Undergraduate Education. In: Martin, J.; Darby, J. and Kjöllström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*. CTISS Publications, Oxford.
- Ellerman, H. (in press). An Experimental Network-Mediated Study Support System. In Verdejo, M.F. (Ed.). *Collaborative Dialogue Technologies and Distance Learning*. Springer Verlag, Berlin.
- Fishbein, M. and Ajzen, I. (1975). *Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research*. Addison Wesley, Reading.
- Fisher, A.S. (1991). *CASE: Using Software Development Tools* (2nd Ed.). John Wiley, New York.
- Flagg, B.N. (1990). *Formative Evaluation for Educational Technologies*. Lawrence Erlbaum Associates, London.
- Fries, C. and Simón, C. (1993). *Interactivity in TeleTraining: Evaluation of Technology-based Distance Learning in Corporate Settings*. Short Contribution presented at the Teleteaching '93 conference, Trondheim, Norway.
- Gagné, R.M. (1977). *The Conditions of Learning* (3rd ed.). Holt, Rinehart and Winston, London.
- Gagné, R.M. (1987). *Instructional Technology: Foundations*. Lawrence Erlbaum Associates, New Jersey.
- Gagné, R.M. and Briggs, L.J. (1992). *Principles of Instructional Design*. Holt, Rinehart and Winston, London.
- Galliers, R.D. (1993). Research Issues in Information Systems. *Journal of Information Technology*, 8, pp. 92-98.

- Galliers, R.D.; Pattison, E.M. and Reponen, T. (1994). Strategic Information Systems Planning Workshops: Lessons from Three Cases. *Int. Journal of Info. Management*, 14(1), pp. 51-66.
- Gane, C. (1990). *Computer-Aided Software Engineering. The methodologies, the products and the future*. Prentice Hall, Englewoods Cliffs, New Jersey.
- GATE (1993) *Multimedia TeleSchool: Case Studies for the Spanish Sites*. Intermediate Report, MTS Project, Universidad Politécnica de Madrid.
- Goodrum, D.A.; Dorsey, L.T. and Schwen, T.M. (1993). Defining and Building an Enriched Learning and Information Environment. *Educational Technology*, XXXIII(2), pp. 10-20.
- Grover, V. and Goslar, M. (1993). Toward an Empirical Taxonomy and Model of Evolution for Telecommunication Technologies. *Journal of Information Technology*, 8, pp. 167-176.
- Hales, M. (1991). A Human Resources Approach to Information Systems Development -the ISU (Information Systems Use) Design Model. *Journal of Information Technology*, 6, pp. 140-161.
- Hall, A. D. (1989). *Metasystems Methodology: A New Synthesis and Unification*. IFSR International Series on Systems Science and Engineering, Pergamon Press.
- Hannum, W. and Hansen, C. (1989). *Instructional Systems Development in Large Organizations*. Educational Technology Publications, Englewood Cliffs, New Jersey.
- Hartley, J.; Tagg, A.; Garber, R.; Barry, D. and Fitter, M. (1991). *Computer Conferencing for Distance Learning*. Final Report to the Learning Technologies Unit of the Department of Employment, Department of Occupational Psychology, Birbeck College, University of London.
- Hauser, J.R. and Clausing, D. (1988). The House of Quality. *Harvard Business Review*, May-June, pp.63-73.
- Hiltz, S.R. (1988). *Learning in a Virtual Classroom. Final Evaluation Report*. Research Report n.25. Computerized Conferencing and Communications Center, New Jersey Institute of Technology.
- Hirschheim, R. and Klein, H. (1989). Four Paradigms of Information Systems Development. *Communications of the ACM*, 32, 10, pp. 1199-1216.

- Holmberg, B. (1989). *Theory and Practice of Distance Education*. Routledge, London.
- Horsley, M. and Beazly, M. (1993). Training Teachers to Use Computers in Communication: Lessons in Orchestration and Harmony. In Davies, G. and Samways, B. (Eds.). *Proceedings of the IFIP TC3: Third Teleteaching Conference, Teleteaching 93*. Trondheim, Norway, 1993.
- Hudspeth, D. (1992). Just-in-Time Education. *Educational Technology*, XXXII(6), pp.7-11.
- Jeynes, J. (1991). The Human Elements of Introducing a New Computerized System in the Workplace. In Winterburn, R. (Ed.). *Realizing Human Potential, Aspects of Educational Technology XXIV*. Kogan Page, London.
- Jonanssen, D.H. (1991). Thinking Technology: Context is Everything. *Educational Technology*, XXXI(6), pp.35-37.
- Kaufman, R. (1987). Identifying and Specifying Requirements for Instruction. In Gagné, R.M. (1987). *Instructional Technology: Foundations*. Lawrence Erlbaum Associates, New Jersey.
- Kaye, A.R. (Ed.) (1992). *Collaborative Learning Through Computer Conferencing. The Najaden Papers*. NATO ASI Series, Vol. 90. Springer-Verlag, Berlin.
- Kaye, A.R. (1993). *Evaluation Instruments and Procedures*. CO-LEARN Consortium, Public deliverable No. 17, The Open University.
- Kaye, A.R., Mason, R. and Harasim, L. (1989). *Computer Conferencing in the Academic Environment*. CITE Report, no. 91. Institute of Educational Technology, Open University.
- Kerr, E. and Hiltz, S.R. (1982). *Computer-Mediated Communication Systems: Status and Evaluation*. Academic Press, New York.
- King, J.W. and Cornell, R.A. (1992). Tools for Managing Design and Development of a Twenty-first Century Technology Base. *EMI*, 29(3), pp.153-161.
- Kovel-Jarboe, P. (1989). Organization and Technology Issues related to Distance Education. *TDC Research Report*, no. 3.

- Kurshan, B. (1991). Creating the Global Classroom for the 21st Century. *Educational Technology*, XXXI(4), pp.47-50.
- Land, F. and Hirschheim, R. (1984). Participative Systems Design: Rationale, Tools and Techniques. *Journal of Applied Systems Analysis*, 10, pp. 91-107.
- Lane, C. and Cassidy, S. (1994). The Role of Technology in the Systemic Reform of Education and Training. *ED Journal*, 8#6, pp.1-21.
- Laurillard, D. (1994). How Can Learning Technologies Improve Learning? In: Martin, J.; Darby, J. and Kjöllnerström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Lauzon, A. (1991). Enhancing Accesibility to Meaningful Learning Opportunities: A Pilot Project in Online Education at the University of Guelph. *Research in Distance Education*, October 1991, pp. 2-5.
- Layzell, P. and Loucopoulos, P. (1989). *Systems Analysis and Development*. Chartwell-Bratt, Lund.
- Lee, P. (1991). Innovative Uses of Existing Technologies and Delivery Systems: Four Case Studies. *TDC Research Report*. no. 14, Telecommunications Development Centre, Univ. of Minnesota.
- Levin, H.M. (1983). *Cost-Effectiveness: A Primer*. Sage Publications, London.
- Lloyd, L. (Ed.) (1991). *Using Computer Networks on Campus 2. Papers from the Second Annual Conference 1991*. Meckler, Westport, London.
- López-Fuensalida, A. (1990). *Metodologías de desarrollo (en el camino hacia el CASE)*. Ra-ma, Madrid.
- Makaney, G.D. (1992). The Design and Implementation of Local and Wide Area Network in Students Affairs. *Journal of Educational Technology Systems*, 20(3), pp. 231-239.
- Maloy, W.L. and Perry, N.N. (1991). A Navy Video Teletraining Project: Lessons Learned. *The American Journal of Distance Education*, 5(3),
- Marchand, R. and Brulotte, R. (1992). Cost Analysis of Distance Education. *Multimedia Journal on New Technologies and Learning in Europe*, 7, pp. 9-20.

- Markus, M.L. (1984). *The Impact of Systems*. Markus, M.L. (Ed.). *Systems in Organizations: Bugs and Features*. Pitman, Boston.
- Martin, J.(1994). How Will Computers Influence the Life of the Student in 1998? In: Martin, J.; Darby, J. and Kjöllnerström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Martin, J.; Darby, J. and Kjöllnerström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Mason, R. (1989). *The Use of Computer Networks for Education and Training*. Report to the Training Agency, Policy and Programmes Division, Sheffield.
- Mason, R. and Kaye, A.R. (Eds.) (1989). *Mindweave: Communication, Computers and Distance Education*. Pergamon, Oxford.
- Mason, R. (1992). Computer Conferencing for Managers. *Interactive Learning International*, 8, pp. 15-28.
- Mason, R. (Ed.). (1993). *Computer Conferencing: The Last Word*. Beach Holme Publishers Ltd., Victoria, British Columbia.
- Matheron, J.P. (1990). *MERISE, Metodología de Desarrollo de Sistemas. Teoría Aplicada*. Paraninfo, Madrid.
- McGrath, J.E. (1984). *Groups: Interaction and Performance*. Prentice Hall, Englewood Cliffs, New Jersey.
- McLagan, P.A. (1989). Models for HRD Practice. *Training & Development Journal*, September
- Merriam, S.B. (1988). *Case Study Research in Education. A Qualitative Approach*. Josey Bass, San Francisco.
- Merrill, M.D.; Li, Z. and Jones, M. (1990). Limitations of First Generation Instructional Design. *Educational Technology*, XX, pp. 7-11.
- Miser, H.J. and Quade, E.S. (1985) *Handbook of Systems Analysis: Overview of Uses, Procedures, Applications and Practice*. John Wiley, New York.
- Moore, M. (1993) Is Teaching like Flying? A Total Systems View of Distance Education. *The American Journal of Distance Education*, 7(1), pp.1-10.

- Morehouse, D.L. and Stockdill, S.H. (1989). Understanding the Influence of a Change Agent Organization on Technology Use by University Faculty and Staff. *TDC Research Report*, no. 7. Telecommunications Development Centre, Univ. of Minnesota.
- Morehouse, D.L. and Stockdill, S.H. (1991). A Technology Adoption Model. *TDC Research Report*, no. 16. Telecommunications Development Centre, Univ. of Minnesota.
- Morgan, R.M. (1987) Planning for Instructional Systems. In Gagné, R.M. (1987). *Instructional Technology: Foundations*. Lawrence Erlbaum Associates, New Jersey.
- MTS Consortium (1992) *Multimedia TeleSchool Project: Technical Annex*. Berlitz European Projects, Frankfurt.
- MTS Consortium (1993). *Multimedia TeleSchool Project: Annual Report*. Berlitz European Projects, Frankfurt.
- Mullings, C. (1994). How will Learning Technology Change the Role of the Teacher by 1998?. In: Martin, J.; Darby, J. and Kjöllérström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Nickerson, R.S. (1981). Why Interactive Computer Systems are Sometimes not Used by People who might Benefit from Them. *Int. J. Man-Machine Studies*, 15, pp. 469-483.
- Noel, K. (1991). Instructional Systems Development in a Large-Scale Education Project. *Educational Technology Research & Development*, 39(4), pp. 91-108.
- Olle, T., Sull, H. and Tully, C. (1991). *Information Systems Methodologies*. Addison Wesley.
- OTA, US Congress (1988) *Power On! New Tools for Teaching and Learning*. OTA-SET-379. US Government Printing Office, Washington.
- OTA, US Congress (1989) *Linking for Learning. A New Course for Education*. OTA-SET-379. US Government Printing Office, Washington.
- Phelan, A. (1992). *DBS Pedagogical Scenarios*. Multimedia TeleSchool project, Public deliverable No. 5, Audio Visual Centre, University of Dublin.

- Phelps, R.H.; Wells, R.A.; Ashworth, R.L.; Hahn, H.A. (1991). Effectiveness and Costs of Distance Education using Computer-Mediated Communication. *The American Journal of Distance Education*, 5(3), pp. 7-19.
- Quade, E.S. (1985). Predicting the Consequences: Models and Modelling. In Miser, H.J. and Quade, E.S. (1985) *Handbook of Systems Analysis: Overview of Uses, Procedures, Applications and Practice*. John Wiley, New York.
- Rapaport, M. (1991). *Computer Mediated Communications*. John Wiley, New York.
- Reeves, T.C. (1993). Research Support for Interactive Multimedia: Existing Foundations and New Directions. In Latchem, C.; Williamson, J. and Henderson-Lancett, L. (Eds.). *Interactive Multimedia: Practice and Promise*. Kogan Page, London.
- Remenyi, D.; Money, A. (1991). A User-Satisfaction Approach to IS Effectiveness Measurement. *Journal of Information Technology*, 6, pp. 162-175.
- Rogers, E.M. (1983). *Diffusion of Innovations* (3rd Ed.). The Free Press, London.
- Romiszowski, A. (1990). *Delivery Systems for Corporate Training in the Future*. Paper presented at the II International Conference "Corporate Training for Effective Performance", University of Twente.
- Romiszowski, A.J. (1981). *Designing Instructional Systems*. Kogan Page, London.
- Romiszowski, A.J. (1984). *Producing Instructional Systems*. Kogan Page, London.
- Rowland, F. (1994). In What Ways Will Communication Technology Change Learning? In: Martin, J.; Darby, J. and Kjöllérström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Rowntree, D. (1992). *Exploring Open and Distance Learning*. Kogan Page, London.
- Rumble, G. (1993). Economic, Organizational and Technological Factors in the Implementation of Technology-led Flexible Learning Systems: The Organizational Domain. *Proceedings of the workshop "Organization, Technology and Economics of Education", COSTEL project*. Copenhagen, January 11-12, 1993.
- Sakthivel, S. (1992). Methodological Requirements for Information Systems Development. *Journal of Information Technology*, 7, pp. 141-148.

- Salisbury, D.F. and Conner, D.R. (1994). How to succeed as a Manager of an Educational Change Project. *Educational Technology*, XXXIV(6), pp.12-19.
- Sankar, C.; Apte, U. and Palvia, P. (1993). Global Information Architectures: Alternatives and Tradeoffs. *Int. Jn. of Info. Management*, February, pp. 84-93.
- Seitz, R. and Bodendorf, F. (in press). Innovative Support Technologies for Tele- and Team-Work at Universities. In Verdejo, M. F. (Ed.). *Collaborative Dialogue Technologies and Distance Learning*. Springer Verlag, Berlin.
- Shackel, B. (1991). Usability -Context, Framework, Definition, Design and Evaluation. Shackel, B. and Richardson, S. (Eds.). *Human Factors for Informatics Usability*. Cambridge University Press.
- Shackel, B. and Richardson, S. (Eds.) (1991). *Human Factors for Informatics Usability*. Cambridge University Press.
- Shaw, M. and Roper, E. (Eds.). (1993). *Quality in Education and Training, Aspects of Educational Technology XXVI*. Kogan Page, New York.
- Silver, G.A. and Silver, M.L. (1989). *Systems Analysis and Design*. Addison-Wesley, Massachusetts.
- Simón, C. (1992). Telematic Support for In-Service Teacher Training. In Kaye, A.K. (Ed.). *Collaborative Learning and Computer Conferencing. The Najaden Papers*. Springer-Verlag, Berlín.
- Simón, C. (1994a). Implementation of MTS Courses in Spain. In Sippel, F. (Ed.). *Implementation and Management of Teletraining*. Proceedings of the Wissenschaftliches Institut für Kommunikationsdienste Workshop. Brussels, November 30, 1993, pp. 23-27.
- Simón, C. (1994b). *Using Telematics from an Institutional Perspective*. Keynote Presentation at the 1st JANUS User Association Conference, Open University of the Netherlands, September.
- Simón, C. and Martín, P. (1994). Experiencia de telemática educativa en GateCOM. *Revista de Educación a Distancia*, no. 8, pp. 94-100.

- Simón, C. y Muñoz, M. (1990). Methodology of Production of Multimedia-Based Training Materials. Proceedings of the XVI Distance Education World Conference, International Council for Distance Learning.
- Simón, C. (in press). Learning Experiences with Collaborative Working Technologies: Some Critical Factors. In Verdejo, M. F. (Ed.). *Collaborative Dialogue Technologies and Distance Learning*. Springer Verlag, Berlin.
- Simón, C. and Zorkoczy, P. (1991). *Towards an Architecture of Technology-Based Training Systems*. Paper presented at the II International Conference "Corporate Training for Effective Performance", University of Twente.
- Simonson, M.R. and Jurasec, K. (Eds.) (1992). *14th Annual Proceedings of Selected Research and Development Presentations*. Association for Educational Communications and Technology, Washington.
- Sippel, F. (Ed.) (1993). *Implementation and Management of Teletraining*. Proceedings of the Workshop, Brussels, 30 November 1993, Wissenschaftliches Institut für Kommunikationsdienste, Bad Honnef.
- Slovacek, S.P. and Doyle-Nichols, A.R. (1991). Enhancing Telecommunication in Teacher Education. *Journal of Research on Computing in Education*, Winter 1991, 24(2), pp. 254-264.
- Souder, W.E. (1993). The Effectiveness of Traditional vs. Satellite Delivery in Three Management of Technology Master's Degree Programmes. *The American Journal of Distance Education*, 7(1),
- Sousa, J. de (1994). Just-in-time Information for Collaborative Thinking. In: Martin, J.; Darby, J. and Kjöllérström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Spencer, K. (1991). Modes, Media and Methods: the Search for Educational Effectiveness. *British Journal of Educational Technology*, 22(1), pp. 12-22.
- Stern, E.; Kelleher, J. and Cullen, J. (1992). *Evaluating Learning Technology Innovation*. Preliminary Common Evaluation Framework, ARTICULATE Project, Public deliverable 01, DELTA Programme.
- Stockdill, S.H. and Morehouse, D.L. (1989). Case Study Evaluation of Three Technology Projects: Keys to Technology Selection and Project Success. *TDC Research Report*, no. 8. Telecommunications Development Centre, Univ. of Minnesota.

- Stockdill, S.H. and Morehouse, D.L. (1991). Critical Factors in the Successful Adoption of Technology: A Checklist based on TDC Findings. *TDC Research Report*, no. 15. Telecommunications Development Centre, Univ. of Minnesota.
- Tetzeli, R. (1994). The Internet and your Business. *Fortune*, March 7, pp.56-61.
- Verreck, W. (1993). Flexible Learning: Demand, Delivery and Production Factors in Implementation. *Proceedings of the workshop "Organization, Technology and Economics of Education"*, COSTEL project. Copenhagen, January 11-12, 1993.
- Waggoner, M. (1992). A Case Study Approach to Evaluation of Computer Conferencing. In Kaye, A.R. (Ed.). *Collaborative Learning Through Computer Conferencing: The Najaden Papers*. Springer Verlag, Berlin.
- Warburton, R.G. (1993). Designing Object-Oriented User Interfaces Using User Driven Design. *KNOW HOW Consultancy and Services*, IBM Applications Development and Solutions Centre, IBM UK Ltd.
- Weston-Bartholomew, W. (1991). Some Difficulties in Describing Human Potential in Educational and Training Technological Systems Using Computers. Winterburn, R. (Ed.). In Winterburn, R. (Ed.). *Realizing Human Potential, Aspects of Educational Technology XXIV*. Kogan Page, London.
- Westrup, C. (1993). Information Systems Methodology in Use. *Journal of Information Technology*, 8(4), pp. 267-275.
- Whistlecroft, L.; Graham, R. and Darby, J. (1994). What Computer Based Learning Materials will be Available and How Will They be Produced? In: Martin, J.; Darby, J. and Kjöllérström, B. (Eds.) *Higher Education 1998 Transformed by Learning Technology*, CTISS Publications, Oxford.
- Wijnhoven, A.B.J.M. and Wassenaar, D.A. (1990). Impact of Information Technology on Organizations: The State of the Art. *Int. Jn. of Info. Management*, pp.35-53.
- WIK-GATE (1992). *Research Concept Evaluation*. Public Deliverable nb.4, Multimedia Teleschool project, Wissenschaftliches Institute for Kommunikationsdienste, Bad Honnef.
- WIK (1994). *Management Requirements for MTS*. Public deliverable 32, Multimedia Teleschool project, Wissenschaftliches Institute for Kommunikationsdienste, Bad Honnef.
- Willcocks, L. (1991). Introduction: Human Resource and Organizational Issues in the 1990s. *Journal of Information Technology*, 6, pp.121-127.

- Wilson, T. (1991). Overcoming the Barriers to the Implementation of Information Systems Strategies. *Journal of Information Technology*, 6, 39-44.
- Witt, C.L. and Wager, W. (1994). A Comparison of Instructional Systems Design and Electronic Performance Support Systems Design. *Educational Technology*, XXXIV(6), pp.20-24.
- Wolpert, E.M. and Lowney, F.A. (1991). GC EduNET: Building and Electronic Community. *Educational Technology*, XXXIV(4), pp.21-24.
- Wolstenholme, E.F.; Henderson, S. and Gavine, A. (1993). *The Evaluation of Management Information Systems*. John Wiley, Chichester.
- Work, C.K. (1993). The Future Development of Campus-Wide Information Systems: Towards the Virtual Campus. *Journal of Information Networking*, 1(1), pp.41-52.
- Yourdon, E. (1988). *Managing the System Life Cycle*. Yourdon Press. Prentice Hall, Englewood Cliffs, New Jersey.
- Yourdon, E. and Constantine, L.L. (1979). *Structured Design. Fundamentals of a Discipline of Computer Program and Systems Design*. Yourdon Press, Prentice Hall, New Jersey.
- Zorkoczy, P. (1989). *Development of Instructional Technology Architecture and Associated Strategies*. Technical Report No. 25, Centre for Electronic Education, The Open University, Milton Keynes.
- Zorkoczy, P. (1991). Developments coming from Telecommunications and Training-related Services. *Proceedings of the TBT Workshop*. Madrid.
- Zorkoczy, P. (in press). Educational Scenarios for Telecommunication Applications. Verdejo, F. (Ed.). *Collaborative Dialogue Technologies and Distance Learning*. Springer Verlag, Berlin.